VOL. IX. No. 6. November, 1902.

THE Psychological Review

EDITED BY

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AND
J. MARK BALDWIN, Princeton University

WITH THE CO-OPERATION OF

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PUBLISHED BI-MONTHLY BY

THE MACMILLAN COMPANY,

41 N. QUEEN ST., LANCASTER, PA.

66 FIFTH AVENUE, NEW YORK.

AGENTS: G. E. STECHERT, London (2 Star Yard, Carey St., W. C.), Leipsic (Hospital St., 10), Paris (76 rue de Rennes).

The Psychological Review.

The regular numbers of THE PSYCHOLOGICAL REVIEW are issued bimonthly, on the first days of January, March, May, July, September and November, and contain about 112 large octavo pages each. The space is about equally divided between research work and critical articles on the one hand, and reviews and discussion of psychological literature on the other.

The Annual Subscription is $4.00 (Postal Union, $4.30); Single Numbers, 75 cents (Postal Union, 80 cents).

Back numbers and volumes, beginning with Vol. I., 1894, may be obtained at the same rate.

As part of THE REVIEW there is published annually

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PRESS OF
THE NEW ERA PRINTING COMPANY,
LANCASTER, PA.

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VOL. IX. No. 6 NOVEMBER, 1902

THE PSYCHOLOGICAL REVIEW.

A BIOLOGICAL VIEW OF PERCEPTION.

BY DR. THADDEUS L. BOLTON,

University of Nebraska.

Our purpose in the following pages is to revise one of the old categories of psychology in the light of some ideas borrowed from biological study. The inapplicability of the old categories to modern research has long been felt. The terms memory, association, attention, perception, etc., have served the purposes and methods of introspective psychology pretty well; and while they are not entirely satisfactory and applicable to experimental and comparative methods, they cannot be dispensed with right away, and besides no satisfactory substitutes have been offered for any of them. The chief and most serious objection to them is that they do not all refer with equal clearness to concrete realities which every observer can discover and identify. It requires too often judgment and careful interpretation to assign a certain phenomenon to one category rather than to another, and furthermore some phenomena of mental life persistently refuse to fall under any of the older categories. The almost complete failure of experimental studies along the old hypotheses, such as attention, reasoning, conscience, etc., would seem to indicate that these terms do not or cannot refer to uniform realities; they overlap one another and each seems to cut the grain of intellectual life at a different angle. What one excludes may not be included in any or all the others.

We shall submit the term perception to a short study to show that a large part of that which enters into every perceptive act

has been generally overlooked. The common view of perception held by most psychologists is something like this: A percept of an object is constituted of all the different sensations from all the various sense organs to which it appeals. The percept is a complex of sensations arising in connection with brain processes, both those directly initiated by the afferent currents and those aroused by these. The orange is the classical illustration in English as the sausage is in German. It is said that the orange has color, form, taste, smell, touch, etc. Now while this theory is not very critical and leaves many points of interest untouched, we are led to believe that these different sensory effects are immediately discriminated on the presentation of the object to the different organs of sense. No attempt will be made to deny that the percept is a complex of all these different sensations, but it is contended that these are the most superficial as well as the most obvious elements that enter into the percept. They are all the results of direct afferent nerve currents excited by the object, but they are, however, not the only or most important elements in the percept. There is in addition to them a much larger number of elements in every percept which are the results of afferent currents from the organism itself and these constitute the background or the framework in which these direct afferent effects inhere, so to speak. The older authors have recognized both an active and a passive part in all perception or have allowed that perception might be either passive or active, active perception being the more sure, accurate and discriminating with regard to its object. In active perception consciousness was said to go out toward the objects; it reacted upon them. In this reaction of consciousness all the associates of the elements presented by the direct afferent currents came up to interpret that which was directly presented. Some writers speak of presentative and representative elements in percepts. We propose to study more minutely from a comparative point of view this reaction upon the object and the associates which come up to interpret and illuminate what is immediately offered. The part that the back stroke plays in perception needs to be pointed out and emphasized—that which comes into the percept

by the way of the back door. Psychology is much indebted to Professor James for prying open the back door and to Morgan and others for propping it open permanently. It may in time be necessary to caution ourselves that the psychological tabernacle still has a front entrance, but until the back way is better known the caution is scarcely needed.

Our thesis is: Perception is an attitude toward an object as well as a complex of sensations, the attitude being characteristic of the object. To gain an understanding of what is meant by an attitude toward an object, we must trace perception down through the animal series to its earliest biological beginnings. In that way we shall see it gradually fading into pure automatic and instinctive performances. Perception reduced to its lowest terms is an act. The study of perception becomes synonymous with a study of animal activity. All perception below the level of conscious reflection amounts simply to a way of acting. In so far then as animals perceive objects they act in definite ways towards them. These various definite ways in which animals act towards objects are known as instincts, and objects to which animals do not possess any kind of instinctive or inborn method of acting are perforce unperceived by them. Those performances of animal life which are rigorously determined and carried out irresistibly in the presence of definite objects, always in the same way, are inchoate perceptions. Without doubt they are to be found only in the lowest forms of animal life, where perception is then synonymous with instinct. In perceiving the object the animal acts towards it, and even though we come up in the animal scale as far as man this fact of acting towards objects still enters largely into the perception of them. Perception in man must be considered only as a much modified and complex method of adjusting himself to his environment. The lower forms of life must act in the way they do, otherwise they are cut off. But even in the higher forms there still survives bodily action. We might almost paraphrase Professor James' sentence and say: 'Objects are presented to us, we act in determinate manners towards them and thus perceive them.' Objects to the lower forms of life, carrying with them as they do possibilities of life and death, are for this

reason emotional interests and these find their reality in the animal's acts. Only those objects with life and death possibilities for the lower forms of life, and those with pleasure and pain possibilities for the higher forms, have interests and are acted towards — consequently perceived.

Consciousness, if there be any in animals of low degrees of development, is without functional importance and can be left out of consideration. Professor Morgan allows that it may exist and calls it epiphenomenon. When, however, the reaction which an object provokes in an animal is imperfect and can be improved by successive trials, or when the instinctive performance may be modified by experience, which is practically the same thing as by repeated trials, consciousness comes to have functional value and the material it uses to modify the performance is presented by the currents that flow backward from the organism during activity and are initiated by the movements the organism makes. They are not the results of direct afferent currents started by the object that is present to the senses. The object provokes the movement and this in turn supplies through the back door the data which consciousness uses in the modification or perfection of the movement itself. The nervous processes excited by the object are perfectly continuous and joined in a causal series with those that provoke the movements which are allowed in all forms of life to be the animal's response to the object exciting the first processes in the series. The function of consciousness is nowhere to interfere or interpolate itself into this causal series, which is complete without it. It is a misconception of consciousness to suppose that it works in that way. We are far from denying to consciousness functional value and by no means do we do so when we declare that it can never interpolate itself between two nervous processes in a series which would be imperfect and disjointed without it. The idea that consciousness is a psychical minister to join in holy and functional wedlock forever nervous processes which could otherwise occur synchronously, rather than causally, is most certainly erroneous, even if it has gained wide currency. Now let us choose as an illustration of the way in which consciousness

modifies or perfects a movement the case of a newly hatched chick learning to discriminate foods.

It will be admitted that the first peck is purely automatic and is initiated by a moving particle. If every moving particle were good for food and there were no more than enough to meet the needs of the chick, it would peck automatically every moving particle presented, and, the supply and demand being equal, the chick could go on through life without the need of any conscious experience whatever. There would be no perception other than that mentioned above — instinctive performance. But there are two kinds of food, let us say, sweet and bitter, which differ characteristically by forms or colors. The sweet food is pecked and swallowed. The bitter is pecked and rejected after it excites in the mouth the bitter taste. The rejecting movement is provoked by the stimulus in the mouth. After a few trials this kind of food is not even pecked. That which at its first presentation evoked a pecking movement no longer does it; the object incites the animal to pass along. What we are contending for is this: that the elements which have entered into the chick's consciousness to modify its activity toward the bitter food have come chiefly through the back door. The significance of the bitter taste is to be found in the fact that it excited the rejecting movement. Simply as taste the bitter food could have no meaning for the animal, except the animal show some response to it by bodily movement. The currents that flow inward from the organism as a result of its activity initiate conscious processes which become associated with the conscious processes aroused by the afferent currents started by the object as presented to sight, so that when the object is presented again, instead of provoking the pecking movement, the head is rather drawn back and the animal passes on. It is an association or fusion of nervous processes primarily, and this means fusion of conscious states that accompany them. Bitter food is then to this animal the to-be-avoided-and-passed-by.

In this we find a clue to the meaning of all perception. Objects, in so far as they are objects at all, are things to be acted upon. The movements that they provoke are the significant phenomena for consciousness and without provoking motor re-

sponses objects cannot enter into conscious experience. To the automatic frog the snake is the to-be-screamed-at-and-jumped-away-from, while on the other hand, the fly is the to-be-snapped-at. What the object means, then, may be stated by describing the activity of the animal. It is not the color and form of the snake or of the fly that are of chief significance to the frog, but the color and form of the snake as provoking the screaming and jumping-away movement and of the fly as provoking the snapping-at movement which are significant to the frog consciousness. The biological history of color perception is something very similar. Inchoate colors are reactions. A piece of red flannel or other small red objects held down before the frog will excite him to snap, and even though the frog may be frightfully torn by a hook concealed in it, he does not desist. He may be snared several times in succession unless some other circumstance arise to provoke the fear reaction and flight. A moving red color of not too great size means the snapping movement. Red color, or 'the red rag,' for another reason, elicits an entirely different movement from the bull, and a still different one from the turkey gobbler. The red color of an artificial flower will entice certain bees to seek honey. In all these cases the real object, as it appears to human consciousness, remains unperceived. The flower which should, according to the analysts, be smell and taste as well as form and color is acted towards in the same way as if it possessed all the requisites to human consciousness. The consciousnesses of these different animals must be different as their bodily reactions to the colors are different. Over-fine psychologizing might find that the animal had taken one of the concomitants of the object for the whole object, overlooking all the others, and acted accordingly; but it is far simpler and, we believe, more correct to say that a certain stimulus, which is here a moving colored form, is followed by a given response, and that the stimulus gets its significance in the action it provokes.

Instead of children perceiving objects and describing objects in terms of their direct afferent effects, they choose to speak in terms of activity. The colt is said to be 'what runs behind the carriage' and a pig becomes 'what drinks its milk all up.' A

stump speech was described as 'when a man stands up and says a whole lot of things what nobody understands.' The pig is not a combination of colors and form, as we might be led to believe by the synthetic psychologists; it is a moving active thing. The child and the common man of the world use such terms chosen from their experience as have meaning for them; such terms are their own acts. They understand them through the avenue of the back stroke. The scientific man without a doubt finds it better suited to his purposes to describe objects in their direct sensory effects.

Wild animals, deer for instance, may be approached by hunters directly in front when it is possible to float down upon them in a boat so that there is no lateral movement. Just so long as the stimulus does not shift its position upon the sensory surface and thus avoids exciting a reaction towards adjustment, the object remains unperceived. If there be lateral movement, the eye must follow, and this becomes the key that unlocks the movements for flight. A mental state of fear in the deer would have no meaning; it could not be significant except it led directly to flight. The hunter is the to-be-fled-from, and he is nothing else to the deer. The deer has no other attitude towards him and he can have no other so long as he lives in the brush and is hunted.

In vision, perception of form arises through the backward flow from the ocular muscles as they contract and relax to move the eye so that the different points in the outline may fall successively upon the fovea. The recent experiments upon illusions of sight leave little doubt upon this point. Tactual space perception must be explained in a similar way. Differences in location upon the skin are felt as differences in tendencies to movement in relocating points touched.

Until the animal must act differently towards different individuals of the same species, there is really no need for other elements than those supplied by way of the back stroke. In the lowest instinctive and automatic performances the action is identical with the perception; but as we rise higher, the reactions are less and less rigorously determined. A given object is not always responded to in precisely the same way, a greater

variety of objects may be reacted to, and objects differing somewhat in detail may provoke the same and different responses. Practical necessities might then arise for giving definite responses to the slight differences in detail. The lowest animals perceive few objects, that is, they discriminate few. With the growth in multiplicity of instinctive reactions goes growth in discriminative power. Discrimination is shown by different reactions to the objects discriminated. The feeling of difference — the shock of difference, as Professor James puts it — arises from a difference in the bodily reverberations which objects severally excite. Psychical units or mind atoms, if they exist at all, are bodily changes of determinate sorts. That which first enters into conscious experience as perception arises not in connection with the direct afferent currents, but in connection with the backward flow from the motor response. The back-stroke effects come first, and only as discrimination grows and rises to higher importance do the direct afferent effects increase in significance; but they are always bound up with back-stroke effects. The appreciation of direct afferent affects is dependent always upon the increasing variety of motor responses which objects come to provoke in us. Discrimination, then, proceeds not by direct analysis of immediate presentations but through differences in the motor activities which objects excite. The striking difference between the inexperienced animals of the lowest and highest species is this: In the lowest species the objects that are responded to at all provoke definitely fixed and appropriate movements and other objects may not affect the animal's conduct in the least. In the highest species a greater variety of objects provoke responses which are in a large measure random and apparently purposeless. Experience works towards the selection from among these random movements those that are appropriate and serve some purpose, and by repetition makes them stereotyped and definitely fixed. The slighter differences in objects for which, on account of the rigidly determined character and limited number of their reactions, the lower species could show no appreciation, would provoke various random movements in the higher. Those individuals in whom the smallest differences in objects would arouse

the most varied responses would stand the greatest chances of finding a movement that would be appropriate to the differences, and thus gain an advantage over their less plastic fellows and become, through survival, the progenitors of the future generations.

The method of discrimination here offered can be seen more clearly by illustration. A child mistakes a goat for a dog, approaches it too incautiously and is butted over. The general form of four legs, a body, a head and a tail is alike in both and is the exciting cause for the movement of approach on the part of the child. The horns, which hitherto have remained unperceived, become associated with the painful feelings from the disastrous overthrow which is followed by flight, so that the goat no longer incites the child to approach but to retreat. Both goat and dog may now provoke flight until some quality of the dog excites again the movements to approach.

This failure to discriminate may be seen again in the identification of snow and sugar by another child, and here it looks like a recognition of likeness. The child's experience may be conceived to be something like this: The attendant tells the child that what is before him is sugar, and the child observing the object imitates the sound of the voice and says 'sugar.' In subsequent experience the sight of whiteness provokes the muscular contractions which result in the production of the sound 'sugar.' Again the eye falls upon something white—whiteness—and by a reflex mechanism the muscles contract and the sound 'sugar' is uttered. But this time it is the whiteness of snow that has provoked the utterance. Let it be that the child is corrected and told to say 'snow.' Subsequently he will say snow or sugar when whiteness is presented until some new experience is had. Sugar may be offered him at the same time that he is told that it is sugar. It is tasted, so that hereafter the word calls up the tasting movements. Snow is presented and tasted at the same time the word is pronounced. If the two present no objective differences in granulation to the eye, they must be tasted before they can be discriminated. The smaller and finer grains of the one will sooner or later call up the sugar taste, and the flakes of the other the chill reaction, when they

have several times been experienced together, and thus the discrimination will be accomplished.

The need for an enormous variety of bodily responses correspondent and commensurate with the differences among things that must be discriminated was met by the rise of language. The savage who has met a snake or a bear and was frightened and made to tremble thereby, comes home and acquaints his tribesmen by a weakened trembling of his members and a few movements of his hands. So, too, when he tells of the visit of another to his camp he gives first the tribal symbol of his visitor and then passes one hand above the other to indicate the entrance into his tepee and so on through the narrative. The higher civilized man substitutes conventional movements of his speech organs for the conventional movements which make up sign language, sign language being in large part a pantomime in conventional forms of real bodily activities which objects have excited. Thus each increase in the capacity for the discrimination of differences in direct afferent effects was made possible by the fact that bodily movements in the form of speech reactions were excited by the stimuli. Every sensory effect is bound up in a motor, or, as Professor Dewey puts it, sensation is sensation in so far as it is sensation producing motion. For the sensory effect to become apparent it must arouse movement — a perception reaction.

Defective sense perception on the part of children suffering from uncomplicated microcephaly must be interpreted as due more to a lack of proper muscular control for the sense organ. The eyes can be moved freely but objects presented to them do not provoke the usual reaction of fixation. The eyes cannot be controlled, because the nervous structures through which the afferent currents started by the object must pass are so imperfectly developed that these currents do not awaken the reflexes for adjusting the eyes to the object presented. A bitter substance like arrow-root or an irritating one like turpentine is swallowed when placed in the mouth because they do not awaken the usual rejecting movement. The swallowing reflexes being the primordial and fundamental, and hence more easily awakened, are aroused by the substances placed upon the

tongue. The inattention of idiots which is so frequently spoken of — the impossibility of holding the attention upon an object — must be interpreted as an imperfection in the mechanism by which in the normal objects adjust the sense organ so as to take full account of all the qualities presented by the objects. Perception is made possible by a series of reflexes which are successively awakened by an object. When the organism is not sufficiently developed to make possible the perception reflexes, objects are not attended to — they are not perceived.

Passive, bloodless contemplation or perception, which would mean immediate appreciation of direct sensory effects free from back-stroke effects, is less common than we suppose. The dispassionate scientist and the calm, cold, reasoning logician are more often fictions of the litterateur; the experimenter and the arm-chair occupant are animated objects, and, whether you will believe it or not, their perceptions, like all perceptions, are little more than refined emotions; and, thanks to Professor James, most psychologists are coming to believe that emotions get in by the back door. The scientist and philosopher find interests and wax warm and exultant over their perceptions which get their deepest reality and significance in the overflows which they excite. It is the same in everyday affairs. We might speak of a rose as of rose-feeling, of tobacco as of tobacco-interest, or of a beefsteak as of beefsteak-enthusiasm. To perceive a beefsteak it is not enough simply to note the form and color, to smell the odor and recall the taste, but it is as well to feel the bodily effects which the beefsteak makes upon us. The beefsteak is a thing to go into raptures over as well as to taste and smell and see; there is a genuine beefsteak bodily reverberation which is an inseparable part of the perception of it. As the proof of the pudding is said to be in the eating, so the perception of the beefsteak is in a certain sense in the eating. We might go still farther and say that the reality of all perceptions is in large part in the acting. How persistent and compelling is the bodily reverberation in perception may be seen in tasting a bitter substance like wormwood or in smelling a pungent substance like ammonia.

Our thesis then is this: All that objects mean to us is

largely due to the sensations that flow backward from the bodily reverberations they excite directly in us. Perception is an attitude towards the objects perceived. Perceptions grow out of those primitive ways of reacting towards objects which are both emotions and instincts. Mental life is constituted by adding to the direct afferent effects the interpretation which the back stroke gives. Only in this way can the emotional interests attached to objects be understood. The older view has held that emotional interests are grafted on to the combinations of sensations that have entered into the perceptions. This view would turn the order about. Emotional interests as determinate ways of acting come first, and perceptions are refinements and differentiations of these. The method of origin and development is the same in both. Scientific psychologists proceeding by the methods of analysis have penetrated only far enough to discover the direct afferent or sensory effects which enter into our perceptions. A vague and ill-defined theory of mind which is very suggestive of the Platonic doctrine of ideas seems to be implied in the view of perception arrived at by the analytical psychologists. The theory is something like this: Presented objects awaken mental processes which immediately and without further reference construct out of the data an image which is allowed to be a percept. On the contrary, mind is to be regarded as an outgrowth of conduct, a superior and more direct means of adjusting the organism to the environment—it is teleological.

STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF THE UNIVERSITY OF CALIFORNIA.

COMMUNICATED BY PROFESSOR GEORGE M. STRATTON.

VI. 'Geometric-Optical' Illusions in Touch.

BY DR. ALICE ROBERTSON.

The interest which attaches to experiments upon the so-called 'geometric-optical' illusions, viz., the investigation of our perception of space, is not lessened when the investigation is carried into the tactual field. The experiments recorded in the following pages constitute an attempt to investigate, by touch alone, certain geometrical figures which present well-known optical illusions. Since sight and touch are so closely related, and since our theories of space perception are based in the main upon optical phenomena, the following observations may serve to test some of these theories. For example, from his study of reversible perspective, Thiéry[1] arrives at the conclusion that all optical illusion is due to the perspective in any given figure, whether consciously or unconsciously perceived. According to this observer, the convergence or divergence of lines produces in us an effect of depth, or of foreshortening, so that small angles are only larger ones interpreted perspectively, and an object seen near the apex of an angle seems larger than one at its opening, because it appears to be further away, and we connect distance with larger size. It is obvious that the tactual perception of plane figures, the mere contact of the fingers or of the hand upon any part of a flat surface, can produce no effect of perspective. When, however, it is found that illusion remains, serious doubt is cast upon the importance of perspective, even in the sight illusion.

In considering what figures are suitable for experimentation in the tactual field, it is clear that not all figures which pro-

[1] *Phil. Stud.*, XI., pp. 307 and 603, XII., p. 67.

duce an effect upon sight can be used. Simple figures, those containing but few lines, are best adapted to this purpose. If the figure is composed of many lines, a blur of sensations is received, and, as would be said in microscopy, it is difficult to get a sharp definition. The apparatus which was used in the following experiments consisted of black cardboard in which the figures were pricked with a fine cambric needle, the prickings being placed so close together that they could not tactually be distinguished as separate points. Or, in a few cases, the shape of the figure to be experimented with was made by pasting narrow strips upon a larger piece of cardboard, and this outline was either explored by the tips of the fingers, or the hand as a whole was passed over the figure.

Throughout these experiments, active touch has been employed. The rapidity of movement, the amount of pressure exerted, and the portion of the hand which received the sensation, make marked differences in some cases in the amount of illusion. Sometimes an illusion which existed in a very marked degree when the hand as a whole was passed over the figure, became almost inappreciable if the finger-tips were freely used to explore the contour. In other cases the illusion remained whichever method was adopted. As a rule, the hand has been passed rather lightly and somewhat rapidly over the figure, and the judgment has been recorded either in words or in a drawing of the object as it was perceived by the tactual sense.

The agreement or divergence between the illusions of touch and of sight afford a wide basis of classification for the experiments here described. In very few cases only can the tactual illusion be said to be merely in the same, or in a reverse direction from that which is found in sight. Other phenomena of illusion also appear, *e. g.*, illusions of curvature where lines are straight, or illusions of greater length or height where no difference exists in reality. Generally speaking, however, the whole set of experiments is divisible into two classes. The first includes those figures in which the illusion follows the same direction as that of sight. The second includes those figures which afford an illusion in the opposite direction. Other phenomena connected with these figures will be noticed in the description.

Class I.

The experiments which fall under the first class consist of a miscellaneous group of minor illusions which are common and well known in the field of sight. The purpose has not been to make a complete investigation of the phenomena revealed here, but merely to find out whether illusion exists, and, if so, to what extent it resembles the visual phenomena. These figures were presented from time to time to several subjects, no attempt being made, except in one or two cases, to vary the conditions.

1. *Müller-Lyer Illusion.*—In this well-known figure a marked tactual illusion exists. For purposes of experiment the oblique lines at the extremities of the horizontals were not joined close to the latter. Space enough was left so that the ends of the horizontals could be distinctly felt. In every case illusion

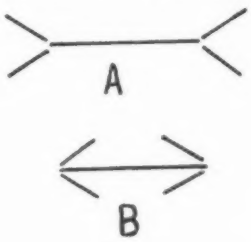


Fig. 1.

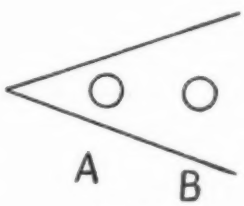


Fig. 2.

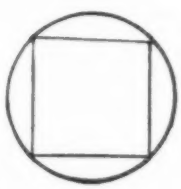


Fig. 3.

in regard to the length of the line was very apparent. It was in the same direction as that found in sight, but greatly intensified. That is, when compared by the sense of touch alone, *A* (Fig. 1) seemed not only longer than *B*, but the difference in length between them seemed much greater than appears to sight.

2. *Illusion of Convergent Lines.*—Experimentation upon a suitable figure of the pattern represented in the drawing gave perfectly definite and unvarying results. When the hand is passed over the figure and the sizes of the two circles are compared, that one (*A*) which is in the apex of the angle seems the larger—a result similar to that which is found in sight. The result in question seems to be due to a blending, to a certain degree, of the sides of the angle with the periphery of the circle and an interpretation of this as meaning that the circle *A* is larger than *B*, *B* being relatively uninfluenced by the lines

near it. If this be true, then the apparent size of *A* relative to *B* should change with a change in its position relative to the apex of the angle. This supposition seems to be confirmed by a few experiments conducted for the purpose of testing it.

3. *Perception of Angles.*—In the optical illusion presented by Fig. 3, the circle seems to be flattened somewhat where it touches the corners of the square, while the sides of the latter are very slightly bent inward. The same phenomena greatly accentuated appear also in the tactual illusion. In experimenting with this figure, subjects were requested not to explore the contour with the figure-tips. A record of the impression received by passing the hand back and forth over the figure as a whole, was made in drawing by each subject, and samples of the data obtained from two subjects, *S* and *N*, are given below (Figs. 4 and 5).

Fig. 4 represents the impression which subject *S* received

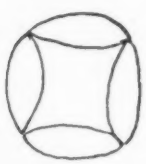


FIG. 4.

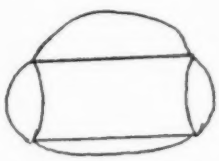


FIG. 5.

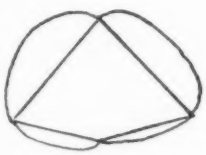


FIG. 6.

when the hand was passed over the figures as a whole in any direction. The sides of the square curved inward, and the periphery of the circle seemed to be divided into distinct segments, which flattened very much as their extremities approached the corners of the square.

Fig. 5 represents the impression received by subject *N* of the same figure. In this case the hand was passed from right to left or *vice versa* across the figure as a whole, at which time the square lengthened horizontally, the shorter sides only seeming to curve slightly inward. The circle seemed to be an ellipse somewhat flattened at the corners of the inner rectangle. When the figure was turned through 45°, and the hand was moved as before from right to left and back again, then the square became a flattened diamond shape, and the circle an ellipse somewhat flattened at the corners of the inclosed figure

(Fig. 6.) To this subject, 'horizontal' distances, that is, distances right and left, seem distinctly longer than equal vertical ones. Also, the upper part of a figure which is felt by the hand as a whole, usually seems higher and more distinct than the lower part of a symmetrical figure. Thus, in the two positions recorded above (Figs. 5 and 6) the curve of the ellipse is higher above than below, as is also the point of the diamond in Fig. 6.

4. *Illusions of Contour.*—A tactual illusion similar to that

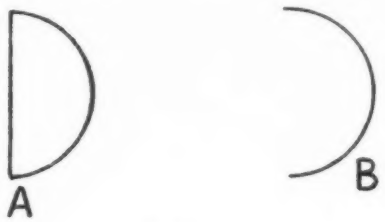


FIG. 7.

FIG. 8.

which is found in sight appears also when the hand is passed over two semicircles, the one closed and the other open, as represented in the drawing (Fig. 7). In this case the arc of the open semicircle seems to flatten out and to become the arc of a larger circle. Besides this illusion in contour another one appears in *A* which is not observed in sight. When the contour of *A* is perceived by the hand as a whole, the first impression is that of a figure composed of two curves, one of which is flatter than the other (Fig. 8). The curve of the arc of the circle seems to impress itself upon the chord and it appears to bulge slightly.

Similarly, if the two squares *A* and *B* (Fig. 9) are compared in the manner above described for the semicircles, the open figure *B* will seem the larger. In some cases *A* is felt as a square, *B* as a rectangle whose longer sides are horizontal. In other cases both *A* and *B* seem to be lengthened rectangles, *B* seeming the longer of the two. In the comparison of the semicircles and of the squares, the illusion in each case corresponds to what we find in sight, and probably for a similar reason, viz., the inclusion within the figure of some of the outside free space.

5. *Ring Segments.*—When the two segments (Fig. 10), which are objectively equal, are compared by touch, an illusion similar in direction to that of sight is very evident. Not only is a tactual illusion apparent when the segments are objectively equal, but also when the upper segment is actually larger than the lower, and when to sight no illusion whatever exists. That is, it is found by experimentation that, if two segments are compared in which the inner curve of the upper segment is equal to the upper curve of the lower (Fig. 11), a tactual illusion is apparent in a larger number of cases. In Fig. 10, 80% of the judgments obtained from five persons were in accord with the ordinary visual illusion, that is, *A* seemed smaller than *B*. At the same time, in the other 20% of the judgments, *A* was con-

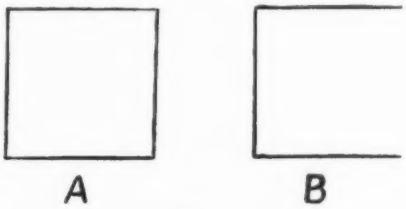
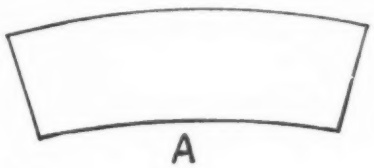


FIG. 9.

sidered either larger or equal to *B*, or the subject was in doubt. The evidence for illusion in this figure is by no means so conclusive, so unvarying in its effect on the tactual sense, as it is in vision. On the other hand, it is remarkable that in the unequal segments represented in Fig. 11, so large a percentage of judgments should give evidence of a tactual illusion. The larger size of *A* in Fig. 11 is very evident to the eye, yet when the comparison is made by touch, in 42% of the judgments *A* is considered smaller or equal in size to *B*. If the cards are turned at right angles, and the segments are compared in this position, the errors in judgment are increased. In the case of Fig. 10, the increase is not large, 81% of the judgments are in favor of the smaller size of *A*, while for Fig. 11, 56% of the judgments are that *A* is either smaller than *B* or equal to it. The error in these figures seems to indicate that the tactual comparison of the two segments becomes a comparison of the lengths of the two more closely approximated curves, rather

than a comparison of the size of the segments as a whole. This is thought to be the reason why an increase of errors occurs when the cards, and consequently the segments, are turned at right angles to the positions represented in Figs. 10 and 11. In this position the oblique sides of the segments are brought directly under the fingers, and hence come into more prominent notice. The tips of the fingers naturally follow the slanted edge of the upper or right-hand segment, and thus they are brought some distance within the slanted edge of the lower, or left-hand segment, and the former is considered the smaller.



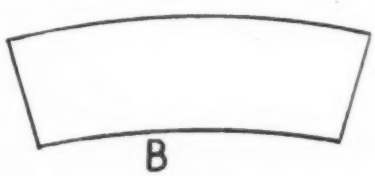
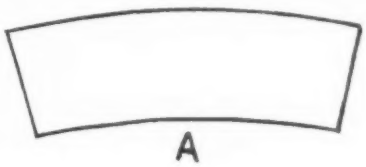


FIG. 10.



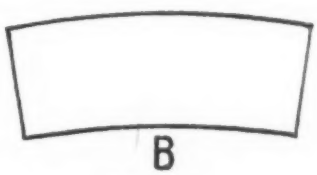


FIG. 11.

In each of the preceding figures certain tactual illusions occur which are in the same direction as those which appear to the eye and which seem analogous to the optical illusions. As has been said, these optical phenomena have been ascribed to perspective as the primary cause; but in the experiments here presented perspective cannot enter, and yet the results are the same. While it does not necessarily follow that the phenomena of sight and touch should be referred to the same cause, yet the results here obtained are thought to diminish the force of perspective as a fundamental cause of illusion even in sight.

Class II.

1. *A Quantitative Comparison of Lines of a Varying Number of Interruptions with an Uninterrupted Line of Standard Length.*—The experiment here described is intended to investigate the phenomena which appear when lines variously interrupted are compared, by the sense of touch alone, with an uninterrupted line. The results show a reversal of the illusion which appears in the visual field, and instead of an overestimation of the interrupted extents such as takes place in vision, there is underestimation, *i. e.*, the interrupted lines seem shorter than they actually are.

The apparatus which was used consisted of a number of cards, made of black cardboard, 27 cm. long by 13 cm. wide, in the center of which the lines were pricked. Four kinds of lines were used. First, a plain, uninterrupted, smoothly pricked line (———————). Secondly, a line similar to the preceding but having its extremities defined by a short line at right angles (|———————|). Thirdly, a line defined at each extremity by cross lines and also divided in the middle (|———|———|); and fourthly, a line divided in a similar manner into sixths (|–|–|–|–|–|–|). The cards thus fall into four groups, each group consisting of a series of lines varying in length from 7 cm. to 15 cm. The lines varied by steps of 5 mm. throughout that portion of the series where the difference was actually found to be difficult to perceive. The lengths of the lines composing a series, then, were as follows: 7, 8, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 14, 15 centimeters. The standard line with which all comparisons were made, was a plain unbroken line (———————) ten centimeters in length.

In conducting the experiment the subject was seated with closed eyes before a table of convenient height, upon which his whole arm rested comfortably. The standard card was first presented to him, and then the other cards of any particular set, one after the other, were laid below it for his comparison. He was permitted to pass the hand back and forth from the card to be compared to the standard, and *vice versa*, as often as he pleased before he gave his judgment. The right hand was always used, and no restrictions were placed upon him as to

what part of the hand should receive the stimulation. Sometimes the tips of the fingers alone were used, again the portion of the hand just below the finger-tips. In giving a judgment the subject was asked to state whether the line seemed longer or shorter than the standard or equal to it. A series consisted of an ascending and descending portion, and an equal number of each began with the shortest line and proceeded gradually to the longest, and *vice versa*.

Ten such double series were obtained from each of three subjects, *B*, *S* and *N*, the results of which are shown in Table I. As a matter of fact, series were obtained from many more persons, and the results in many cases were much more striking than those which are here presented. The experiments here recorded are, however, in every way the most systematic and trustworthy. In the table each value for the upper (U. T.) and lower (L. T.) threshold is an average of twenty single determinations, and the equality point (E. P.) and mean variation (M. V.) are an average of forty determinations.

Examination of the table of thresholds shows much individual variation in the ability to estimate the differences between the various lines. All show underestimation, that is, the line which is compared, when really equal to a standard, seems shorter than the standard, even in Group I. There seems to be much difficulty for all subjects to discriminate in the case of this group. In the

TABLE I.

TABLE OF TACTUAL THRESHOLDS AND MEAN VARIATION FOR THE FOUR GROUPS OF LINES.

	Group I.				Group II.				Group III.				Group IV.			
	U. T.	L. T.	E. P.	M. V.	U. T.	L. T.	E. P.	M. V.	U. T.	L. T.	E. P.	M. V.	U. T.	L. T.	E. P.	M. V.
B	10.4	10.4	10.4	.12	10.9	10.8	10.8	.25	11.3	11.2	11.2	.28	11.4	11.2	11.3	.43
S	11.2	10.8	11	.24	12.3	11	11.6	.43	12.1	11.6	11.8	.37	12.5	11.8	12.1	.53
N	10.7	10.6	10.6	.40	11.8	11.7	11.7	.34	11.2	11.2	11.2	.37	12.6	10.5	10.5	.38

cases here reported one subject, *S*, shows an underestimation amounting to 1 cm., the other two subjects each average about one half a centimeter of error. The amount of error in the case of subject *S* is always large, but increases at an even rate with the number of interruptions, so that the line with the greatest number of interruptions seems in his case to be the shortest. For subject *B* the amount of underestimation is somewhat less in each case, but it proceeds at the same even pace, and a line much divided seems shorter than one objectively equal but undivided. The case is somewhat different for *N*. For this subject the effect of the limiting lines at the extremities in Group II. is marked by a sudden increase in the amount of underestimation. The compared line in Group II. seems to be shortest of all, while the compared lines in Groups III. and IV. relatively lengthen. But even with this subject the line containing the greater number of interruptions is equal to the uninterrupted line and not longer, as is the case in sight.

From the data furnished by these experiments, we may conclude that when a line ten centimeters in length, definitely marked at its extremities, and with or without interruptions in its length, is compared with a plain unbroken line objectively equal to it, it appears shorter to the tactual sense, or is underestimated. In general, this result agrees with the conclusion at which Professor Parrish[1] arrived in his investigation of similar phenomena with passive touch. He used lines 64 mm. long, all being marked at their extremities and variously interrupted in their extents. He considers that the results which he obtained clearly point to a reversal of the optical phenomena. Dr. Dresslar,[2] on the other hand, concludes from experiments which he conducted with both active and passive touch, that the tactual illusion follows the same direction as the illusion of sight. A study of the data of the latter's experiments, however, given in Tables I. and II., pp. 334, 335, of his article, suggests that perhaps a transition-point from under- to overestimation may be found in them, between the long and the short

[1] *Amer. Jour. of Psy.*, VI., p. 514.
[2] *Amer. Jour. of Psy.*, VI., p. 314.

interrupted intervals. Certainly in Table II., in which the judgments are given upon longer lines (5 to 16 cm.), there is a decided falling off of the relative number of judgments in favor of the greater length of the filled space. Indeed, the writer himself remarks on page 337, that 'when the spaces to be compared are more than 10 cm. in length, the illusion does not hold so steadily.' In fact, from about 10 cm. on, the illusion tends to take the opposite direction from that which appeared below that length and from that which appears in the visual field.

From the results of a few tentative experiments upon short interrupted intervals, an analogy between our sensations of touch and our perception of time is suggested. It is well known that time of a given length, but interrupted at regular intervals, seems within certain limits to be shorter than an equal unbroken period. It has been found, however, that for very short intervals the illusion changes in character, and such periods when interrupted at regular intervals appear to be longer than an equal unbroken time.[1]

For the purpose of investigating this matter experimentally a number of cards were prepared, on each of which there was marked off a short space defined by limiting lines. The spaces formed a series and were respectively 8, 9, 10, 11 and 12 mm. wide, defined at each extremity by a pricked line one centimeter in length. The standard for comparison consisted of a space 10 mm. wide which was broken at regular intervals by five lines (| | | | |). Thirty series (150 judgments) were obtained from each of the three subjects, *B*, *S* and *N*. The method of right and wrong cases was adopted. The cards to be compared were presented in no regular order, but were shuffled at intervals. A parallel experiment, thirty series for each person, was also carried out, the standard in this experiment being an unbroken space of 10 mm. long (| |).

The results of the two experiments are given in Table II. The data for both experiments from each subject are placed one below the other so that their comparison may be more easily made. The upper line of the table gives the widths of the unbroken spaces, or the variables which were compared with

[1] Meumann, *Phil. Stud.*, IX., p. 264, and XII., p. 127.

TABLE II.

Sub.	No. of Exp.	Character of Standard.	Distribution of Judgments when Variable was:																						
			8 mm.					9 mm.					10 mm.					11 mm.					12 mm.				
			L.	S.	E.	E. or S.	D.	L.	S.	E.	E. or S.	D.	L.	S.	E.	E. or S.	D.	L.	S.	E.	E. or S.	D.	L.	S.	E.	E. or S	D.
B	30			30					30					28	1	1		2	16	12			10	8	11	1	
	30			28	2			2	18	4	1	4	7	11	5	2	4	25	1	4			28	1	1		
N	30		1	27	2			1	26	3			9	17	4			18	9	3			30				
	30		1	29				2	19	9			15	5	10			29		1			30				
S	30		6	19	5			5	17	8			9	11	8		2	17	8	4		1	24	1	3	2	
	30		1	23	5		2	2	19	7		2	7	10	8		5	24	1	5			29			1	

the two standards. The letters L, S, E, E or S, and D in the second line, stand respectively for the judgments longer, shorter, equal, equal or shorter, and doubtful. The number of judgments of each kind is arranged in two lines for each subject, the upper line giving the judgment of comparison with the broken standard (| | | | |), the lower line, those with the unbroken one (| |). Thus, taking the first two lines which represent the judgments given by the subject *B*, we see that an unbroken interval of 8 and 9 mm., when compared with the standard, is thought to be shorter each time. The comparison of an unbroken interval 10 mm. in length with an equal broken interval gives 28 judgments of shorter, and the unbroken spaces of 11 and 12 mm. give a predominance of the judgments of shorter and equal. Contrasting these results with those obtained from comparison with the unbroken standard, it will be seen that for this subject there is ample evidence for an overestimation of intervals where the standard is 10 mm. in length. In these sets the 10 mm. and 11 mm. intervals are the most instructive. Considering those for subject *N*, the 10 mm. unbroken interval is considered shorter than an equal broken interval 17 times, and equal only 4 times; while the 11 mm. interval is thought to be longer 18 times, and either shorter or equal 12 times. When the same two intervals are compared with the unbroken standard, the judgments of shorter for the 10 mm. interval diminish, while those for 11 mm. show almost no illusion.

In the case of subject *S*, the results are not so conclusive. Unlike the first two subjects, he knew the purpose of the experiment and felt, himself, that this knowledge was a difficulty in the way of giving a ready judgment. When the unbroken standard was used for comparison, there is a slight decrease in the judgments of 'shorter' and an increase of 'doubtful' and 'equal' for the 10 mm. interval; while for 11 mm. there is a decided increase of judgments of 'longer' and 'equal' with a decrease of 'shorter.' These results, when considered by themselves, may be said to indicate a tendency toward the overestimation of interrupted intervals. Taken in connection with those given by the two other subjects, there is a strong indica-

tion that in the tactual field a general law holds true, viz., that long interrupted extents are underestimated, short ones overestimated.[1]

The underestimation of interrupted extents by the tactual

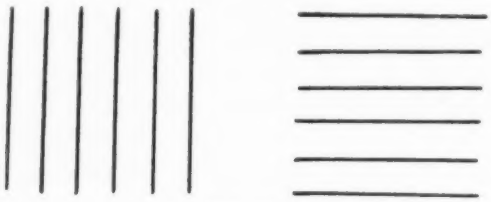


FIG. 12.

sense is also shown in the comparison of squares which are composed of either horizontal or vertical lines. When squares similar to *A* and *B* (Fig. 12), whose sides are 10 cm. long, are pricked in cardboard and are felt by running the hand as a whole over them from right to left, or vice versa, then an illusion appears in the reverse direction from that perceived by sight. *A*

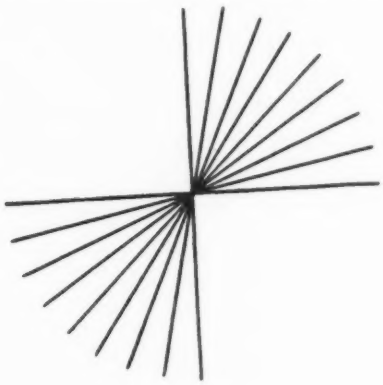


FIG. 13.

seems to lengthen so that it appears to be a rectangle whose horizontal sides are longer and whose vertical sides are shorter. On the other hand, *B* seems to shorten horizontally and to lengthen vertically. Similar phenomena occur in the figure which

[1] This is in accord with the results of Professor Rieber, to be published in the forthcoming volume of *Harvard Studies*. Dr. Rieber has very kindly placed his results in outline at our disposal for comparison.

represents alternate quadrants of interrupted and uninterrupted extents (Fig. 13). When the hand is passed over such a figure, the open or uninterrupted quadrant seems decidedly the larger. While this may be taken as added proof that interrupted extents are underestimated, yet the apparently very large size of the open quadrant is probably due in part to the inclusion by the hand of much of the surrounding free space. The arc through which the hand sweeps in passing over the open quadrant, not being well defined, seems greater and may in reality be greater than that through which it passes when feeling the quadrant filled with radiating lines. The tactual illusion in this case is analogous to that which is found in sight, although in an opposite direction. For, while in sight the uninterrupted quadrant seems smaller than the filled one, this is doubtless partly due to the fact that we compare the *arc* of the 'filled' quadrant, *i. e.*, the ends of the radiating lines, with the *chord* of the arc of the adjoining open quadrant. The optical illusion, then, is partly due to the *leaving out* of some of the space which belongs to the open quadrant. The tactual illusion, on the other hand, is heightened by the *taking in* of additional space.

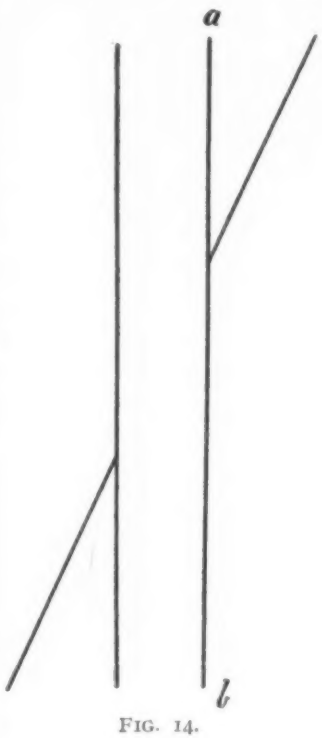


FIG. 14.

2. *Poggendorff Figure.*—The Poggendorff figure has long been a favorite subject for investigation as an optical illusion. Many theories center about it and the closely related Zöllner figure, but so far as I know no attempt has been made to investigate the tactual phenomena connected with it. A few tentative experiments gave very constant and somewhat surprising results. For whether the subject was or was not already acquainted with the optical illusion which appears in this figure,

whether he had or had not previously seen the figure which was presented to him, the illusion was very apparent, but in a reverse direction from that which appears to the eye. In the optical illusion which this figure presents, the lower left half of the oblique line appears to be *too low*, and not directly continuous with the upper right half (Fig. 14). In the tactual illusion, on the contrary, the lower left half of the oblique seems *too high* to be considered a continuation of the upper right half of the same line.[1] Moreover, the amount of displacement in the tactual illusion seems to be much greater than in the visual. It was, therefore, thought worth while to conduct a set of experiments for the purpose of making some quantitative determinations. A figure was constructed having one part of the oblique line movable, so that the amount of displacement could be easily measured. The verticals were placed 30 mm. apart, and the oblique crossed them at an angle of 40°. At no time was the subject permitted to see the figure. The sheet of cardboard upon which it was constructed was placed before the subject so that his arm was at right angles to the transverse line over which his hand should pass. It was found that if this line were slowly and carefully traced with the finger-tips, the illusion either did not appear or was very faint. In all cases it was required to judge of the direct continuation of the two parts of the oblique line by passing the flat of the hand over it, either alternately up and down, or in one direction only, as the subject desired. As a matter of fact, most persons settled into the one method of passing the hand from right to left downward over the line.

The experiment was conducted with four persons, *B*, *S*, *D* and *A*. From each of these, five double series were obtained. A descending series began with the transverse lines really continuous, although in no case did they seem so to the subject.

[1] Professor Dresslar proposes an explanation for an illusion of displacement of crossed lines which he considers may explain the optical illusion in the Poggendorff figure, and which by implication, at least, seems to be intended as an explanation of the tactual illusion in this figure. In my own experiments with the Poggendorff figure, the tactual illusion is shown to be in an opposite direction from that which appears in sight, and this fact would seem not only to render Dr. Dresslar's proposed explanation inadequate for the illusion in touch but also to throw doubt upon that offered for sight. See *Amer. Jour. of Psy.*, VI., p. 275.

The movable side was then moved downward by steps of 2 or 2.5 mm. to the point where the two halves of the transverse line seemed to the subject to be continuous, and then below that

TABLE III.

AVERAGE THRESHOLDS AND MEAN VARIATION.

Subject.	Upper Ave. Thr.	Lower Ave. Thr.	General Average.	Mean Variation.
B	— 15.2 mm.	— 24.1	— 19.6	4.6
S	— 27.2	— 30.1	— 28.6	8.3
D	— 24.0	— 30.1	— 27.1	4.5
A	— 45.0	— 50.3	— 47.7	9.0
Aver.	— 27.8	— 33.6	— 30.7	6.6

point until the left side was clearly too low. An ascending series retraced these steps to zero. Every such series, of course, gave two thresholds. In tabulating the data a calculated equality point was found of all the upper thresholds for the upper limit of continuity, or upper threshold. In a similar way the lower limit of continuity was found. Table III. gives the results which were obtained from each of the subjects according to this method. In the table the minus sign signifies the distance of displacement downward, measured along the line *ab* in Fig. 14.

FIG. 15.

It will be seen that the mean upper threshold for all four subjects is — 27.8 mm., the mean lower — 33.6 mm., thus giving a general average of about — 31 mm. That is, the lower left-hand portion of the transverse line must be moved downward 31 mm. on an average before the two halves seem to be continuous. If we contrast this number with that which was obtained by Burmester[1] in his investigation of the optical illusion in the Poggendorff figure, we find a very

[1] *Zeitschrift für Psychologie*, XII., p. 369.

wide difference in the amount of displacement which the two senses of sight and touch reveal. With a breadth of 30 mm. between the verticals and an angle of 40°, this investigator found an average of −5.09 mm. as the amount of displacement which was required to make the lines look continuous when the figure was in a vertical position.

With some persons the two halves of the oblique line felt as if they were parts of parallels, but the lower left-hand portion seemed to be at a higher level than the upper right-hand portion. It seemed to be the unanimous opinion of those who experienced this illusion that the feeling of 'too high' was due in large part to the vertical parallels. These lines, it was thought, guided the hand downward, below the point where it should cross the space between the verticals, and in order to reach the lower portion of the transverse line an actual upward effort was necessary. In order to test the influence of the verticals upon the illusion a second figure was made, omitting the vertical lines altogether (Fig. 15). This, like Fig. 14, was made with one side movable, so that the amount of displacement could be measured. Five double series were obtained from each of three subjects, *B*, *S* and *D*, and the upper and lower limits noted as before. The data are tabulated in Table IV., and some very interesting results appear. Thus, in the

TABLE IV.

TABLE OF AVERAGE THRESHOLDS AND MEAN VARIATION WHEN VERTICALS ARE OMITTED.

Subj.	Aver. Upper Thr.	Aver. Lower Thr.	General Average.	Mean Variation.
B	+ 5.3	+ 2.6	+ 4.0	3.95
S	− 7.2	− 8.3	− 7.7	3.49
D	+ .7	− 3.7	− 1.5	2.5

case of *B* the direction of illusion changes, and the lines seem continuous at some point above where they really are so. The judgments given by subject *D* vacillate above and below the zero point, and if we take the average of the two thresholds to be the point where the two lines would seem continuous to this subject, we find it to be − 1.5 mm. In this case, then, the illusion is practically nothing. With subject *S* the threshold

always falls below zero, on an average -7.7 mm. From the data it seems clear that in the absence of the verticals the tactual illusion is very greatly weakened and almost nil. In experimenting with a similar figure, Burmester found that the optical illusion was much weakened and took an opposite direction. This experimenter was at the same time his own subject, so that it is possible that if he had operated with other persons, individual differences would have appeared as they do here.

An attempt was made to counteract the influence of the verticals by filling in the space between the end of the oblique lines with lines running horizontally. The vertical parallels are of course suggested by the ends of the horizontals, but since the lines in the transverse direction are the more prominent, it was thought that they would exert the greater influence and weaken the illusion, or perhaps reverse its direction. Several figures were made, in all of which the inclination of the oblique line remained constant, 30°, but in which both the lengths of the horizontal lines and their distance apart varied. The results of experimentation indicated a decided weakening of the illusion, but in no case was reversal obtained.

In whatever position the Poggendorff figure in its normal form was laid, illusion was apparent. The amount of pressure exerted, and the rapidity of movement, seem to have an effect upon the amount of apparent displacement. Thus, in the case of a figure in which the oblique lines were fixed, it was found that, with hard pressure and rapid movement, the lower left-hand line seemed too high; whereas, with the same pressure approximately, and slow movement, the two halves of the oblique line seemed to be continuous.

Various theories suggest themselves as a partial explanation of the tactual illusion which is exhibited by the Poggendorff figure. That the verticals in some way influence the amount and direction of illusion in both sight and touch is obvious enough. To some persons they seemed to exert a mechanical influence in actually leading the hand astray, so that in passing downward from the upper right-hand oblique to the lower left, an upward effort is necessary in order to find the lower part of the line,

leading the subject to consider that that portion of the line is on a higher level. An attempt was made to get tracings of the path which the hand described in passing from one portion of the oblique to the other. This was done by placing strips of smoked paper in the path of a wire which was attached to the hand. Thus, in one instance when the lower oblique was moved downward 10 mm., in passing the hand from above downward the two halves seemed continuous, while in passing from below upward the lower left part of the oblique seemed too high; in these two instances, however, no difference can be detected in the two tracings. That part of the curve which represents the path of the hand between the verticals is almost a straight line in both cases, and each is the normal and regular continuation of the first part of the tracing. In another instance, the two obliques were separated by a vertical distance of 18 mm. To the subject the lines seemed continuous with both the upward and downward movement, and the smoked paper tracings were two perfectly even and smooth, almost parallel lines. In a third instance the obliques were separated by a vertical distance of 23 mm. At this point they seemed continuous to the subject, while the tracing shows many irregularities. These, however, occur, not only in the space between the verticals, but throughout the lines, and may be ascribed to natural tremors of the hand. There is no evidence that there is an actual upward movement of the hand corresponding to the effort which some subjects believed they felt.

Data obtained from figures similar to those used in these experiments have afforded a basis for opposing theories of space perception. The perspective theory of Thiéry has already been mentioned. He sees in the Poggendorff figure also a definite perspective effect which is the cause of the apparent shifting of the two halves of the oblique line. Professor Wundt[1] considers that the cause of the optical illusion in this figure is the overestimation of the acute angles. The perspective effect, he maintains, appears only when one fixates a point monocularly, at which time the displacement of the oblique

[1] 'Die geometrisch-optischen Täuschungen,' *Abhandl. d. königl. sächs. Gesellsch. d. Wissensch.*, XLII.

lines disappears entirely. The 'ästhetisch-mechanische' theory of Lipps,[1] offered first as an explanation of spatial form, has later been applied to geometrical optical illusions. Among other figures, this writer discusses the Poggendorff figure. He applies to it his theory of the interaction of opposing forces, and considers that it suggests the action of the two forces of gravity and vertical extension. The oblique line represents a force approaching, but not attaining, verticality. In the struggle this force is regarded as the primary activity, and as primary activity is overestimated.

We have, then, at least three explanations of the phenomena of the Poggendorff figure. It is here shown how the same figure may give very different sensations to the skin. How are the facts to be reconciled? If the optical phenomena of this figure are due to the overestimation of the bending of the obliques away from the vertical, according to Lipps, or if they are due to an overestimation of the small angles, according to Wundt, why should not these causes operate in the field of touch, and, if they do, why should opposite effects be produced upon the tactual sense? Likewise, no explanation for the optical illusion in the ring segments satisfies the touch phenomena in the same figures. Here again, perspective effects and the overestimation of small angles are offered in explanation. But the illusion persists in touch, when none is apparent to sight, and when all perspective and almost all angle effect is lost completely. The data which are afforded by experiments in the tactual field suggest a revision of the theories so far offered for spatial illusions in general. These theories are in the main founded upon optical phenomena. From what appears in the tactual field it is reasonable to suppose that further study may assist in elucidating this very complex and difficult problem.

[1] 'Raumästhetik und geometrisch-optische Täuschungen,' *Schriften der Gesell. für psy. Forschung*, Vol. II., p. 295.

FEELING AND SELF-AWARENESS.

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Of all facts of the mind having important bearings upon life and art, none are by nature so hard to approach as feelings. We overlook them, because we look beyond them. They stand in such relation to self that while we have a feeling for every phase of the mental life, we cannot, without the most careful effort, form an idea of feeling.

I.

Thought, when viewed from within, refers to an object other than itself; feeling, when looked at from the same point of view, lacks objective reference; thought and feeling are often thus contrasted. Feeling is always felt, and can be symbolically represented and thought; but to do so, one must form an image of himself in some emotional attitude. The usual method of portraying thought and feeling by setting them over against each other is valid, however, only for purposes of introduction. To bring the matter to exact statement, one must add that thoughts are also felt. Every thought is part of that continuum of immediate experience called feeling. They are not entirely different: they unite in every moment of mental life.

It is not easy to say where, among mental states, objective reference begins and ends. When a little girl cried because a pile of books, in tumbling down against a table, must 'hurt'; when, in an absent-minded hour at the beach, the tide comes in and wets one's coat, awakening a feeling of discomfort and semi-alarm which he thinks of as belonging to the things around him instead of to himself; when a well-known professor, after a wearisome journey, sees himself reflected in a mirror at the other end of the omnibus he is entering, and thinks it is 'some broken-down school-teacher' entering from the opposite end; when a religious devotee, filled with mystery and dependence,

feels united in being with the object which he worships — in these and in innumerable similar experiences, objects are clothed with feelings very much as the sky is clothed with blue and the stars with space.

This objective reference of feeling is not unusual. At one of the earlier stages of mental development, where the difference between 'outer' and 'inner' experiences is not yet realized, this projection of feeling is the rule. The mind, moreover, never outgrows it. In all cases of intense or uncontrolled feeling, objects are clothed with the inner mood. Nature always wears the colors of spirit: to the melancholy she is melancholy, just as to the jaundiced she is yellow. A landscape, looked at through a yellow glass, is 'cheerful'; looked at through a blue glass, it is subdued and still. Everyone has known the mood when 'evermore most weary seemed the sea, weary the oar, weary the wandering fields of barren foam,' and the utter soul tedium when 'hateful is the dark-blue sky, vaulted o'er the dark-blue sea.' All mysticism is marked by this projection of feeling. In a recent book called 'The Story of My Heart,' scores of passages like the following occur: "I spoke to the sea: though so far, in my mind I saw it, green at the rim of the earth and blue in deeper ocean: I desired to have its strength, its mystery and glory." The mystic doctrine of 'the ground of the soul,' that 'apex of the mind' which is not merely united to God but one with Him, of which Eckhart says, 'Diess Fünkelein, das ist Gott,' involves the identification of feeling with its object. 'I live, yet not I, but God in me'; 'I and my Father are one.' In the mystic experience the difference between that which is outer and that which is inner is broken down and borne away, so that feeling acquires an objective reference and thought a subjective reference which are quite contrary to the usual contrast between them. The difference between thought and feeling in this matter of objective reference is, from a psychological point of view, relative, not absolute; it requires an inference to determine the relation of feeling and the self; we take up with abstractions whenever we part company with that unity of thought and feeling which every moment of mental life illustrates.

II.

Thought is often set over against feeling and sensation as though it were less immediate than they are. On the contrary, however, a thought that is not felt (that is, immediate) and a sensation or feeling that is not discriminated (that is, thought), are abstractions of the same order.[1] This popular opposition results from trying to portray thought, feeling and sensation without a self, experience without a subject. When we stop to think how the different elements of experience stand to each other, it becomes clear that as elements and ultimates they are all abstractions. In times of pleasure and desire, self feels itself one with its object (this, so far as the self is explicitly conscious of itself at all), and at times of pain and aversion it feels different from its object. To hate is to feel different from hate's object; love unites the self with its object. The closeness and inwardness of this felt unity of the self and the immediate object of its interest vary directly as pleasure and inversely as pain, and this relational feeling of unity belongs to the essence of attention, of thought, and of will. Out of it flow all motor processes of adjustment; when the self is wholly implicit, the process is reflex, and when explicit, voluntary. Moreover, motor processes not only may flow from this felt unity, they always arise whenever it is felt. In other words, self-consciousness is a synthesis of many elements, and every new object or image is felt to be either identical with or different from some or all of these elements; and upon this sameness or difference, felt as change (or its absence) in the content of self, depend the forms of interest, the forms of thought and the direction of motor adjustments.

Everyone knows by introspection that there is a difference between feeling, with its internal ebulitions, and an idea which, as an idea, does not involve self-awareness at all. Feelings are private: thoughts are shared or public. Whenever any experience is shared by others, it acquires an objective signification, which may or may not involve externality according as the experience is predominantly one of thought or one of feeling.

[1] Cf. A. F. Shand, 'Feeling and Thought,' *Mind*, Vol. VII., p. 477 ff.

Beauty, goodness and other sentiments are objective without being external to ourselves: they are all reflective and borrow a sort of publicity from the universality of the self-consciousness upon which they rest, a consciousness of the kind of beings to which the private self belongs. The experience of sentiment, however, remains always a private and personal experience: it is impossible to think of it as impersonal, as, for example, we sometimes (though very uncritically) think of a law of nature as impersonal. One's judgment involves a deference to the judgment of society which is not involved in the immediate experience of feeling. So far, all feeling is ours.

III.

Again, it is held that the difference between thought and feeling can be made out genetically, if not analytically — the doctrine of the 'relative priority of feeling.' According to this view thought is highly differentiated and integrated feeling. If feeling were prior to thought, however, we ought to be able to say what kind of feeling came first; and if none can be found which can be so regarded, why designate primitive consciousness as feeling any more than as thought or motor tendency? It is, in fact, impossible to find a pure feeling, or one out of which the cognitive and more complex forms of mental life have grown. In addition to feeling, awareness and motor tendency must be assumed — awareness of something and motor tendency in some direction. At any stage of organic growth at which psychic life can be said to begin, no doubt motor tendencies in harmony with the individual's welfare already exist; but they exist at first as inherited dispositions without ideas of acts, of ends, or of stimuli to either. About all that can be said about primitive consciousness is, a vague immediacy and awareness, as much feeling as thought, as much thought as feeling, fraught with motor tendencies which, when carried out in movements, result in the differentiation of both feeling and awareness.

We cannot say that primitive consciousness is pure feeling, without implying that, by reactions which are not conscious toward stimuli which are not discriminated or apprehended, feel-

ings are changed into ideas, thoughts and self-conscious movement — an implication which Spencer attempted, but failed, to substantiate. Feeling, as a sense of change, has played a large part in the discussion of mental growth, but a sense of change which involves no discrimination at all, being pure feeling, is unthinkable and, for the purposes of genetic theory, useless. What is a shock of change which does not contain an awareness of anything from which or of anything to which change takes place? The introspective differences between thought, feeling and motor tendency are irreducible; and a primitive consciousness that is one of these and not the other two is, to the writer at least, unthinkable.

On the other hand, once grant that early conscious experience is an awareness containing implicit, potential references to self and an object, together with motor tendencies and attitudes, and the exigencies of organic existence in a life-medium are such that differentiation of this primitive unity can be understood. Awareness of a pleasure-giving stimulus means focalization of consciousness upon it, tendency toward it, and movement, which brings more of the stimulus. Constantly occurring variations of movement result in variations of stimulus, variations of pleasure, repetitions or inhibitions of the variations, and so on: we need only to add memory, to see how a continual selection of those movements which bring more pleasure or less pain results. Growth, differentiation within the early unity without doing violence to it and only changing it to enrich and enlarge it, takes place naturally from the nature and conditions of life; and, we might add, this 'biological necessity' finds its positive condition and explanation in the primitive unity of awareness and feeling, rather than in the environment alone. For the individual himself, at the earlier stages of life, 'environment' does not exist, and nothing that does not exist for him can determine his mental growth.

From physiological theory we can derive much to substantiate the view that the experience of feeling is not prior to thought in the genesis of mind.[1] Feeling involves many ele-

[1] Stanley, 'Evolutionary Psychology of Feeling,' holds that feeling is primary, and that pain is the first form of feeling.

ments of the nervous system. The stimulation of sensory paths, reaching the cortex, starts motor discharges which affect the unstriped muscles of the vaso-motor system and certain secretory organs. The cortical motor centers (probably in the Rolandic region) discharge also (1) toward the frontal lobes which add (possibly, as Flechsig and others think) an affective tone to the emotion, and (2) downward toward the reflex centers of emotional 'expression,' resulting in changes in the processes of digestion, respiration and circulation. The muscular changes due to these motor impulses report to consciousness in changes of cœnæsthesia and in kinæsthetic sensations, the cortical centers of which discharge once more to the motor centers of the Rolandic region and these to the frontal lobes. The cells of the frontal lobes (possibly) discharge with another accompaniment of pleasure or pain which affects the centers of voluntary movement either positively or negatively. Of course physiology cannot show that this account is perfect: it cannot even show that the nervous system is necessary to the experience of feeling: but enough is known to make it probable that at the lowest stages of conscious life, feeling is vague, homogeneous and faint, much poorer than any feelings which we know.

IV.

Baldwin's dictionary defines feeling very broadly. "Consciousness as experiencing modifications abstracted from (1) the determination of objects and (2) the determination of action." If we abstract from the determination of objects and from the determination of action, what is left of any reflective experience is some form of self-awareness — some sense of well-being or ill-being, of activity or passivity. So interpreted, this account resembles Professor Wundt's definition of Gemüth: "The totality of states which we ascribe directly to some activity or passivity of our ego."[1] Of course the consciousness of self is not always clear and explicit: quite the contrary. No explicit awareness of the self, as distinct from the not-self, appears until comparatively late. At first, consciousness seems to be centered outward so that feelings are ascribed to objects; but,

[1] Wundt's 'Phys. Psych.,' 4th ed., II., p. 497.

implicitly at first and explicitly at the end of reflective experience, *feeling is always an attributive element in the consciousness of self.* It is true, we are constantly reading our emotions and simpler feelings into the objects before the attention, but such moments are unreflective.

V.

To this law that all feelings are attributive to one self, their unitary character is due. Empirical psychology frequently states the law of habit in a way which recognizes this truth.[1] Many thoughts, ideas and sensations may be presented to consciousness at any one moment, but only one feeling, or sum-total of feeling. The one feeling may contain many elements; one element or another may predominate at any given moment; and the change from one dominating element to another may take place very slowly or very rapidly. The self can, however, be in but one emotional state at a time. Cœnæsthesia illustrates the point. One or another element may predominate at a given moment, but one always feels well or ill or indifferent: he cannot feel all three at once. Moreover, the emotional effect of a series of experiences occupying successive moments of time but felt and thought as a whole, must be one. No matter how many and varied the partial emotional tendencies of the elements of one total experience may be, the emotional tone of the experience as a whole is always a unitary synthesis of the many partial tendencies.

Not only the unity of feeling, but also the feeling of unity in the objects of knowledge is traced by many psychologists to the oneness of the self that feels and possesses the interest. Feeling seems to be the great individualizer of things: love's objects are all unique. On the other hand, no object is unique which does not appeal to the passional nature, which is not an object of interest. It is a position which investigation strengthens, that unity and continuity of interest is present wherever an object is thus individualized. That conative unity and continuity have an 'altogether predominating importance' in the growth of intelligence, has been recently urged by Stout;[2] and conation is but

[1] Cf. Baldwin, 'Mental Development, Methods and Processes,' 1900, p. 216.
[2] Stout, 'Manual of Psychology,' London, 1899, p. 75.

directed feeling. Conation may be analyzed into a feeling of tendency toward or away from some object. Tendency is an irreducible feeling, and its direction toward or away from its object is probably determined by pleasure in the one case and pain in the other.[1] The feeling of tendency and pleasure-pain are never found entirely separate from each other, and yet they cannot be identified.

Professor Baldwin has emphasized the importance of motor habit in the unification of knowledge. "Association has, accordingly, a motor foundation from the first. The elements hold together in memory because they are used together in action. And as the action becomes one, but yet complex, so the mental content tends to become one, but yet complex also."[2] That this view is not, however, inconsistent with the one maintained here, is clear when we consider why things are used together in action. According to Professor Baldwin's view, the synthesis of pleasure and a given stimulus conditions the formation of motor habits. Unity, wholeness and integrity may be regarded, from this point of view, as feelings of relation based upon habitual motor tendencies: but it is due to feeling as a factor in imitation, according to Professor Baldwin, that motor habits are formed. Discriminations, apprehensions of differences, are due to reactions, are functions of movement; integrations, those habits of reacting which underlie the consciousness of unity, may be regarded as functions of feeling. A child's world is one and very simple; not a confusion of many things, but one thing, for lack of movement; reactions develop differences and discriminations.

The question why feeling unifies cannot be answered by saying that it is because the self which feels *is* one, without reasoning in a circle. If feeling were the great unifier, self would be one because felt as one. We are here face to face with a fact beyond which, so far as I see, we cannot go. Unity is simply the category of feeling, and feeling and self-consciousness are not to be separated even in thought. There is no

[1] On this point see Pfänder, 'Phänomenologie des Wollens,' Leipzig, 1900, p. 70.

[2] *Loc. cit.*, p. 310.

feeling without an either implicit or explicit self-awareness. Difficulties arise because the awareness of some object is always crowding self-awareness out of the mind, in so far as self-awareness is a matter of explicit discrimination. The idea of undiscriminated and unconscious self-feelings has suggested itself to many; but the notion has made more difficulties than it has ever overcome, and is inconsistent with the unity of feeling and thought emphasized above.[1]

Feeling individuates, we might say, because feeling is always a feeling of soul activity, and this is necessarily a one-to-one relation; but this is a repetition of the circle in thought, to which we referred above. We must give up all attempts to explain knowledge as the mere tool for the realization of certain states of feeling. Man needs whatever is necessary to complete himself, and knowledge certainly comes within this definition. A distinction must, however, be made between mediate and immediate needs, between those needs which are immediately felt as needs and those which are inferred from the whole course of history and from the nature of experience. Shortsightedness is the weakness of that utilitarian epistemology which insists that nothing is real which is not an immediate pleasure, and that no conception is true which does not serve as an instrument for the immediate satisfaction of man's practical needs. Reflection, based upon explicit self-consciousness, is an original function of spirit under which all immediate satisfactions are transformed. Man experiences an entire transvaluation of values when he passes from the immediate to the reflective stage of experience; he comes to realize that he needs whatever is consistent with the self. Self-consistency (in this sense) or an experience which is self-consistent, that is, complete and lacking nothing, is the ultimate object of all finite need; but it is an object which includes the subject, that is, the need itself. It is essential to this object that it be known as what it is; it is this knowledge which makes it what it is, and hence, this need of all needs can be adequately conceived only as a determination of reflection. Reflective knowledge is not so

[1] This seems to me a great difficulty in v. Feldegg's 'Philosophie des Gefühls'—an unpsychological use of the notion of unconscious feeling.

much an instrument for the satisfaction of need, as the architect who is at once both the builder of personal experience and the chief element in it. Mere feeling cannot give unity and individuality to such an activity, whether this be conceived as producer or as product; and I do not see how philosophy is to avoid simply inferring, and assuming at the same time, that spiritual activity involves a one-to-one relation between itself and its product, that is, a relation of self-consistency, a relation which is at the same time a relating activity, feeling itself to be such and realizing itself as such in a world of objects.

Objects, however, are universals: the only genuine particular is the this-now experience, and the this-now experience reduces at last to feeling, that is, to a self-conscious activity of spirit. Consequently, while it is not feeling that gives individuality to the objects of experience, it is nevertheless true that only those objects possess individuality which are felt. Strictly speaking, it is not the object but the activity that is felt; but it is never easy to say where activity stops and the object begins, and feelings are always being objectified. We speak of feeling a coin in the hand, confusing feeling with sensation, of course; but apart from the touch sensation, the experience *is* one of feeling in so far as it is an activity of the self, and it is certain that the coin possesses unity only so far as it is felt, that is, so far as it is an activity of the perceiving self.

VI.

Von Feldegg identifies the ego or soul with feeling, but thinks that soul-feeling was originally unconscious: in its inmost being it is always so. But what is a feeling or other mental state of which we are not conscious? How can the conscious be said to be an outgrowth of the unconscious? How can knowledge grow from mere feeling? And, does it mean anything at all to speak of a feeling which involves no discrimination?

The great name of Leibnitz, among others, gives dignity to this notion of unconscious consciousness, but we need not here repeat all the arguments which he advances in favor of it.[1] One will be sufficient for our present purpose. Stimuli must reach

[1] Cf. 'New Essay,' New York, 1896, p. 109 ff.

certain intensities before they result in sensations or feelings; but, he argues, the weaker intensities of stimuli must have some effect upon consciousness, as upon the opposite supposition their having any effect whatever becomes unintelligible. We must therefore distinguish between 'remarkable' or noticeable sensation and sensation in general, and hold that there is a vast realm of sensations of which we are never distinctly conscious. This argument, like others which the New Essay contains, assumes that sensation is a sort of thing or objective reality, independent of the self which experiences 'remarkable sensations,' and this assumption is one for which present-day psychology does not find justification. Leibnitz' view, moreover, logically implies that the self is, at the lowest stages of its development, an object of experience, and that it later becomes a subject. In more recent years, the ego has not unfrequently been spoken of as though it were at first an object of experience, then the unconscious subject of a purely objective experience, then the subject of a purely subjective experience, and finally the subject of a universal experience like that of the adult human being. But such a self is not psychological; and as a metaphysical conception it is replete with contradictions for the understanding. There is no genuine self except the self-conscious-of-its-relations-to-other-selves. Self-conscious reflection is for psychology the very essence of a self.

Ribot, quoting Spinoza, holds that awareness of the body and its processes is the soul or self.[1] Spinoza wrote, "The first element which constitutes the actual being of the human mind, is the idea of some particular thing actually existing." In Proposition Thirteen, "The object of the idea constituting the human mind is the body * * * and nothing else." Proposition Fourteen, "The human mind is capable of perceiving a great many things, and is so, in proportion as its body is capable of receiving a great number of impressions." All this is, however, a metaphysical deduction from the ideas upon which Spinoza's Ethics is founded, and I doubt whether Spinoza had in mind the same view of the soul as Ribot,[2] or ever once

[1] Ribot, 'Diseases of Personality,' Open Court Translation, p. 18.

[2] For further reasons for this doubt see below.

thought of that body of pathological phenomena upon the evidence of which Ribot makes the following assertions: "It is the organic sense, the sense of the body, usually vague and obscure, but at times very clear in all of us, that constitutes for each animal the basis of his psychic individuality. It is that 'principle of individuation' so much sought after by scholastic doctors; for directly or indirectly all rests upon it. We may regard it as highly probable that the farther we descend in the animal scale the more the sense of the body preponderates, down to the point where it becomes the entire psychic individuality. But in man and the higher animals the turbulent world of desires, passions, perceptions, images and ideas covers up this silent background. Except at intervals, it is forgotten, because it is unknown."

Ribot's conclusion is drawn from the interesting facts recorded in this work; but the number and novelty of the facts do not add to the logical weight of the argument. The mental effects of alcohol, of a blow on the head, of exhaustion and fatigue, of fever, and of many other well-known stresses point in the same direction as the less common facts which this book records. They all point to the notion which has for several years been the working basis of psychology, viz., the notion of a parallelism between bodily and mental states, a notion which applies to the awareness of self as well as to awareness of objects. Ribot's view, however, goes farther than this mere working hypothesis, holding that bodily states entirely determine mental states, that bodily sensations make up the sense of self, and that the lower animals which have larger bodies, and simpler ones, than man, are more self-conscious than man. On the contrary, the consciousness of self is not a bodily sensation; it is rather a product of social intercourse and appears only at an advanced stage of mental growth. Animals below man in the evolutionary series are not guided by a sense of the kind of beings they are, so far as one can see in their actions; nor are they more individual than man. All the evidence relating to the influence of a growing social consciousness on individuality, tells against this view. Self-consciousness is much more than a simple awareness of the

body; it is a concept, more or less adequate, of a class of beings into which the individual puts himself; and this the lower animals do not seem to possess.

The lower animals are probably not aware of themselves as subjects of experience at all. It may be true that they are more intensely and constantly aware of their bodies than man is aware of his body; but there exists a great difference between being aware of one's body and being self-conscious, between the child's awareness of his feet and hands, and the adult's awareness of himself as the subject of an experience into which feet and hands enter only as elements of content. Spinoza holds that the mind consists, not only in ideas of the body, but also in ideas of those ideas. In Proposition Twenty-two of Part Two, "The human mind perceives, not only the modifications of the body, but also the ideas of such modifications." In Proposition Twenty-nine and elsewhere, he speaks of 'the idea of the idea of each modification of the human body.' Spinoza recognizes degrees of self-awareness such as the immediate happiness of the child, the awareness which expresses itself in the clause 'I am happy,' then, 'I am aware that I am happy,' and lastly, 'I am aware that I am aware that I am happy.' The view of Ribot that self-awareness is awareness of the body, does not take this reflective form of self-awareness sufficiently into account.

Professor Dewey has pointed out[1] that 'the essential difference between me and thee' is the feeling that every consciousness is *my* consciousness. If it were a knowledge it would be universal and objective. Feeling, which, simply because it is individual and particular, cannot be defined, is the immediate sense of self-activity. Self, according to Professor Dewey, is activity. "Through its activity, the soul is; and feeling is the becoming conscious of its own being." Professor Wundt's view of the self is similar. The Actualitätsbegriff der Seele, of which Wundt is the champion, as opposed to the Substanzbegriff der Seele of which he is the foe, is the conception of an activity immediately aware of itself in feeling. Professor Wundt maintains that the soul cannot be adequately represented

[1] 'Psychology,' 1891, p. 247.

at all — first, because it is a subject and never an object, and secondly, because it is a feeling of a particular activity, while objects are universals. According to Professor Dewey, feeling unites the particular self to the universal implied in every instance of knowledge; the will translates the object by attention into terms of feeling. "From the standpoint of psychology, consciousness is always both objective and subjective, both universal and individual" (p. 24). "If we consider this activity in the value it has as manifesting to us something of the nature of the universe, it is knowledge; if we consider it in the value it has in the development of the self, it is feeling; if we consider it as an activity, including both the universal element which is its content and the individual from which it starts and to which it returns, it is will" (p. 22).

Feeling is always the feeling of an either implicit or explicit self, and feeling varies with the intensity or weakness, the success or failure, the tension or freedom of this activity. The view of Professor Wundt that feeling has three dimensions, viz., Lust-Unlust, Erregung-Beruhigung, Spannung-Lösung, is one for which there is much evidence.[1] Students of mental diseases frequently distinguish emotional conditions of heightened from those of lowered tension, the terms which they use indicating something more than variations of pleasure and pain. Moreover, introspective analysis is continually running across variations of feeling which are, with great difficulty, classed as hedonic. Exaltation, for example, is sometimes pleasant, as in moments of successful effort, but sometimes painful, as in insomnia and other mental disorders.

VII.

One's actual feelings with reference to self are closely connected with the content of the self notion at the various stages of its growth and can only be described in terms of this content. A large group of sensible elements, *inter alia*, enter into it — visual and tactual images of the body and its parts as distinct

[1] Cf. Max Brahn, 'Experimentelle Beiträge zur Gefühlslehre,' *Phil. Stud.*, Bd. XVIII., p. 127 ff. Brahn studies the pulse-variations as effected by feeling, and finds in them empirical confirmation of Wundt's view.

from and related to other objects in space; motor images of bodily movements, and the sense of motor potential; cœnæsthesia, and certain auditory, olfactory and gustatory sensations of the body which are always with us. These constitute what Wundt calls a 'permanent group of ideas' to which other elements of the complex self-idea are assimilated; they are the first elements of self-awareness. The different feelings which accompany the different sensations are, for our present purpose, not important; for many of them we have no descriptive terms or names. These sensations would not, however, become a consciousness of self at all, were they not feelings as well as sensations, and did not their feelings, like all feelings, contain an implicit self-awareness. The sense of well-or-ill-being must have marked the earliest awareness. As the powers of special sensation, dependent upon physiological structures (developed by use) unfold, the sensations are already saturated with feeling. "The point," says Höffding, "at which the ideas and their combinations obtain an influence over feeling cannot therefore be far from the beginning of conscious life, though this influence may not be plainly apparent until a later stage."[1] As perception grew into memory and ideation, as the various stimuli assailing the senses were remembered, recognized and grouped, as images became vague and general, the immediate sense of well-or-ill-being may have become anticipation, fear, and sorrow. Most likely fear came to play a predominating part at this stage.

What interests us most at this point is, first, the probability that the sense of well-or-ill-being must have been present along with sensation from the first, and, secondly, that although this immediate sense contained from the first an implicit self-reference, no consciousness of self as a subject of experience exists until a later time. Pleasure-pain is attributed to extra-corporal things in space, or to the body itself as a thing in a world of things. Self feelings of personal identity and personal agency depend for their rise upon various factors. Feelings, when some development in powers of sensation has been realized and when not due to strong or sudden stimuli, arise more slowly than

[1] Höffding, 'Outlines of Psychology,' New York, 1893, p. 233.

sensations; and analgesia may exist without anæsthesia, and vice versa, under the influence of drugs, extreme cold, hypnotism, etc. This may have aided in the process of self-differentiation.

The relation of opposition between self and every particular object, and the effort of an organism to adjust itself to new stimuli, involving as it does feelings of strain, of muscular co-ordination, of unified activity, must have contributed much to the growth of the self. Especially the effort toward adjustment to other organisms must have tended to develop a sense of adjustment which is potentially a sense of self-activity. The most varied and unpredictable stimuli in the environment of any organism are due to other organisms; they are the ever uncertain and mysterious things, but not wholly mysterious. The fact of character, or uniformity of uncertainty, must have called forth uniformities of expectation and adjustment, as Baldwin has urged. The effort of an individual to adjust himself to such uncertainties may tend to bring to a focus all the lines of tendency toward the thought of self. Effort is, moreover, a psychologically irreducible feeling and is capable of rising to an obtrusive intensity in consciousness. The memory that, of other organisms, some always flee, some always attack, while others always share, etc., must also contribute to the growth of the self-thought. Then there is the recognition that other organisms treat things and each other in a manner very familiar. The individual organism's actions are a problem to other organisms as truly as their actions are a problem to him, and his problem is the same as that of others. Imitation comes before self-consciousness, and the imitated adjustments of individuals to each other and to their common environment serve as aids to the generalizing process which results in the idea of a class of beings to which the individual himself belongs, and to the feeling of self-identity. Meanwhile, the fact of self-interest, not yet realized as self-interest, present in all feeling and directing all activities to the realization of self, obtrudes more and more, tending always to become a discrimination and an emotion. Finally, language, or some system of arbitrary symbols for the communication of thought and feeling, gives universality and consistency to the thought of self. The rise of uni-

versality and consistency seems to be one with the rise of language and dependent upon it.

All the influences tending to the growth of the self notion are covered by the term imitation as used by Tarde, Royce and Baldwin. Baldwin's Dictionary defines imitation as 'any repetition in thought, action or both which reinstates a copy.' Self-awareness must be conceived as such a copy. Except perhaps in its crudest elements, as vague bodily feeling, it is a function of social experiences: social experience emphasizes and defines it. When the self-idea first crosses the threshold of discrimination, it is an awareness of self as a being sustaining certain relations to other beings, of a being of instinct, impulse and convention (using this term in a very broad sense), of certain habitual attitudes and hedonic capacities, of a being who belongs to certain classes of beings, and whose subsistence as a member of this class and that consists in certain types of activity, thought and (consequently) feeling. Not that all this comes suddenly into consciousness — far from it. Every instance of social experience, of experience involving more than one organism, tends to emphasize some one or more of these elements; and there is no self-consciousness which is not a consciousness of the imitatively realized relations of self to other selves. There is no self-knowledge which does not involve feelings of particular relations of self to other selves, to nature or to reality; and it is a question whether nature and reality are not, for us, always, in so far as they are reflectively experienced, personal — whether our relations to them, so far as they are reflectively conceived, are not necessarily social in type. Self-awareness assimilates to itself, all along the process of its growth, all impulses and instincts, pleasure-pain capacities, ideas and motor attitudes; they are its content, while it is their form and unity. Self-feeling is never a feeling of self in general. No wraith of a general self is felt except as the object, never as the subject, of thought. Self-consciousness of the reflective type is paradoxical in so far as it is the consciousness of a particular-self-sustaining-constant-relations-to-other-selves. The self gets its reality from the immediacy of its own particular existence. Here, as always, it is the particular that is felt; self-feeling is

feeling of my particular self as doing, suffering or thinking some particular thing. Even in this case we are, however, dealing with a social product. The sense of personal identity is, as Ormond contends, a function of the social consciousness, and it is this sense of personal identity or selfhood which gives to the emotional life the reflective type of unity which marks all æsthetic, ethical and philosophical emotions.

VIII.

This is clearly manifest in the feelings of familiarity, generality and wholeness which enter into the reflective syntheses of memory, conception, judgment and inference. The discovery that, by the same law, vapor rises, rain falls, and the moon swings round the earth, awakens a strong emotion due to the variety of effective tendencies gathered into the one resulting mood, from the feelings of unity and generality which enter into the thought of these phenomena. The value of a work of art is said to depend upon the complexity of a unified series of images or perceptions, each of which possesses its own emotional tendency but so related to the series as a whole as not to disturb its dominant mood. If we ask ourselves why this is true, we recall that such syntheses are very useful and even necessary to the existence of mind and the mental life. These emotions are the premiums which nature has put upon singleness of view, upon economy of the attention, upon intellectual adaptation. If we further ask why singleness and simplicity of view please, no answer, except that reactions which conserve and enrich the self are always accompanied by pleasure, is possible. "To the question, why this unity pleases, no answer can be given except the fact itself."[1] Failure to realize mental simplicity and singleness, means failure of the mind itself. The unity demanded is unity of the mind with itself, self-consistency; and this is simply a demand for continuity and universality of experience, for an experience containing no want or incompleteness, no interruption or unresolved manifoldness. Unity, pleasure and ex-

[1] Ormond, 'Foundations of Knowledge,' 1900, p. 224.

istence come so near to each other here that to ask why unity pleases is tantamount to asking why unity is unity. The question attempts to apply the bare form of thought to itself.

It is sometimes said that the demand for unity in our world is a demand of the æsthetic consciousness. To the present writer it seems to be just as much a demand of the logical and of the ethical consciousnesses; indeed, is it not at last a demand of the self in all forms of its activity? Professor Ormond maintains that 'it finds its tap-root in the intuition of self-consciousness.' Moreover, there is a tendency in some writers to limit the æsthetic consciousness to the reflective experience of unity in the sphere of perception alone. Calkins[1] so defines æsthetic emotion. According to this usage, the 'associative connections, emotional revivals, volitional and ethical reverberations'[2] are not to be considered essential to the æsthetic experience itself. Hegel[3] maintained that the unity of nature and spirit which is immediately presented in beauty is always qualified by the sensuous externality which embodies it. Consequently, to speak of the beauty of truth, the beauty of holiness or the beauty of character is allowable only upon condition that we define truth, holiness and character, as some primitive peoples and advanced philosophers have tried to do, in terms of things of the objective world. If we accept this limitation of æsthetic experience to the consciousness of the unity of self with objects of perception and their representations in memory, it follows that beauty involves unity, but not that all unity is beauty or beautiful.

The passion for unity is to the mind what the old 'instinct of self-preservation' was considered to be to the organism — a passion for being and reality; and there is a purely formal point of view from which it may be said that what the demand for unity demands is at last only itself. Writers have maintained that this is a logical, others that it is an ethical, demand. Perhaps it were better to regard it as a trait of self-consciousness, rooted in reflective self-feeling, underlying and explaining the æsthetic, ethical and logical unities.

[1] 'Introduction to Psychology,' 1901, p. 278.
[2] Baldwin, 'Handbook: Feeling and Will,' 1891, p. 239.
[3] 'Philosophy of Mind,' Wallace tr., p. 169.

Emotions, in actual experience, are never general or abstract, but particular.[1] One often realizes, in looking back over a given series of past experiences, that he has enjoyed or suffered similarly throughout them all. I now recall that my emotional attitudes and tendencies were the same or similar throughout a series of many experiences and thus realize the 'spirit of a country,' the 'atmosphere of an author,' or the 'genius of a composer.' But these are neither 'abstract emotions' nor 'emotional abstracts' (if indeed there is any difference between these). The abstract thing is the thought of the emotional attitudes common to the entire series of particular experiences: emotion is always particular.[2] There are emotions peculiar to the logical functions, but not a logic of the emotions. Such an experience as the spirit of a country is a logical concept and, like other logical concepts, it embraces an image to which a feeling of generality attaches and into which it enters; but this feeling of generality is totally different from the 'spirit of the country,' being in quality like such concepts as landscape, garden, crowd, etc. The feeling of generality is distinctly *my* feeling, but it may be symbolized and made the object of thought. Moreover, owing to the social forms of consciousness, one reflects that there must *be* generality; one ejects generality into his thought of the world.

Apart from self-consciousness, emotions are abstractions; as such they are thoughts, not emotions. It is of course possible to study these thoughts about emotions, to determine their logical relations to each other, and to arrange them in a systematic scheme; and this is necessary to the science of æsthetics; but such treatment of the emotions bears an even looser relation to the psychology of the emotions than the syllogism bears to the psychology of inference.

Æsthetic pleasure is never pleasure in beauty in general, or in any general characteristic possessed by all the parts of the

[1] For the opposite view see Ribot, 'L'Abstraction des Emotions.' *L'Année Psychologique*, Vol. III., p. 1. Also Urban, 'The Problem of a 'Logic of the Emotions' and Affective Memory,' PSYCH. REV., Vol. VIII., p. 262 ff. and p. 360 ff.

[2] Cf. Calkins, 'Introduction to Psychology,' 1901, p. 264. Also the writer's review of Ribot's 'L'Abstraction des Emotions,' PSYCH. REV., Vol. V., p. 78 f.

object and noted before the beauty is felt: the emotion of beauty does not depend upon the assimilation of an object to its type. It is an immediate experience, the feeling of a relation between the ego and some sense-object. To enjoy the beautiful is to feel that self and something whose apprehension depends upon sense-processes, together, constitute one whole, to feel the same state of activity in a manifold of experiences, and to feel this reflectively, that is, discriminatingly, self-consciously. The æsthetic worth of an object is measured by the manifoldness of the details, each possessing its own emotional tendency, which unite in enhancing a single dominant mood; but it is also measured by the degree of inwardness and closeness felt to exist between the self and its object.

We are not advocating a mystical theory of the identification of self with things, or of thought with its object — that is a different matter. One feels in harmony with those stimuli which give him pleasure: one loses or forgets himself, is 'taken out of himself'; or takes the object over into himself, whenever he recalls or perceives them. Æsthetic judgment is like all judgment in this respect: it differs from many others in two ways, first, in being the enjoyment of something that stimulates sensation or the memory of sensation, and secondly, in that it occurs only to reflective consciousness, to a being or beings conscious of themselves. To be an experience of reflective consciousness means to be thought of as sharable by the entire class to which the self belongs, and this social reference is essential to the æsthetic judgment. Moreover, for the same reason, the beautiful object must possess some sort of human significance: in some way it must suggest the experience of man. Children enjoy bright colors, rhythmic series of sound or movement, and things that stimulate the sense organs and muscles to healthy activity, but not beauty, in the reflective sense of the word. One of the clues which lead children to self-consciousness and reflective experience is just the imitative effort to understand why older persons place such high values upon Sistine Madonnas, Beethoven Symphonies, St. Chapelles, etc. Perhaps the purest of æsthetic pleasures are those of classic orchestration, and they are so because, psychologically

speaking, self and sound, for the time, enter into one larger and more real experience — not really, but in play, in simulation and pretense.

In every great work of art, however, there are images suggesting opposed emotional tendencies or capable of suggesting them, and it may be asked how, if there is no emotional subsumption, such divergent tendencies can be joined within a single poem or other work of art. It is said that every work of art unites many emotional tendencies in a dominant mood, and the remark conveys some truth, but it is a mistake to say they are united as species are united in a genus. In Tennyson's 'Lotos-Eaters,' for example, the dominant mood of self-indulgent ease in a land where it seems always afternoon is apparently disturbed by the emotional tendencies of such images as,

> "wasted lands,
> Blight and famine, plague and earthquake, roaring deeps and fiery sands,
> Clanging fights, and flaming towns, and sinking ships and praying hands."

At first thought it may seem as though the dominant mood of this poem should be disturbed by the emotional tendencies of such images. As a matter of fact, however, one is not conscious, in reading the poem, of such disturbance; and if we were conscious of it, it would argue a defect in the poem itself. Nor are there reasons for saying that these images awaken unconscious emotional tendencies, related to the dominant mood as species to a genus and contributing something to the strength and richness of the former. That they strengthen the dominant mood and exalt the artistic value of the poem, everyone realizes. So also do the passages referring to home and country, with the calls to activity in their behalf which the memory of them brings with it — the passages beginning with, "Dear is the memory of our wedded lives, etc." But if these images do not disturb the mood of the poem, opposed as they are to it, I do not see how any theory of emotional subsumption can account for the artistic strength of the poem.

That the principle of contrast plays a large part in all art, and a very large part in the poetry of Tennyson, is well known. Almost any passage in Tennyson illustrates the fact — the

quatrain from 'In Memoriam' beginning, "Old Yew, that graspest at the stones, that name the underlying dead," for example. For two reasons such contrasts do not destroy the emotional unity of the poem. In the first place, it is impossible, as we have above seen, for the reader to experience two emotions at the same instant, and some sort of emotional unity is therefore certain to result from any reflective combination of sensuous images such as we have here. In order that the work be a work of art, it is necessary that the resulting emotion be not one of disgust, distress, or unsatisfied conation of the ideal kind; and in a mood-poem the dominant mood must be sustained. In the second place, the emotional unity is not disturbed in the 'Lotos Eaters' (*e. g.*), because the contrast-images are so handled as to define and emphasize the images of the gods lying beside their nectar, without awakening the corresponding contrast-emotions at all. If it be asked how contrast-images can be introduced without the corresponding contrast-emotions, we answer that feelings are usually slower than ideas to develop (as we have above seen), and that the contrast-images here follow each other in such rapid succession as to produce only a confused and vague result, like 'a tale of little meaning, though the words are strong.' What would be the result upon this poem if, instead of this rapid sequence, some one of the images like 'flaming towns' were dwelt upon at such length as to bring out all the agonizing details of a burning city? The poet relies upon the slowness with which emotions develop as compared with the contrast effect of the images themselves. Contrasted images tend to define and clarify each other, but contrasted or opposed emotions tend to destroy each other. It is now known that 'emotional expression' has much to do in determining the emotion itself, and of course the same muscle cannot both contract and relax at the same time, cannot 'express' both sorrow and joy, distress and comfort, at the same instant. To awaken emotions opposed to the dominant mood of a mood-poem would be to lessen or destroy the artistic value of the poem, but to intensify and define the imagery of the dominant mood by contrasts so used as to avoid awakening opposed emotions increases the art-value of the poem.

The self-reference of the so-called moral emotions is recognized by all. The simple liking of childhood develops into the gratitude of reflection with a marked egoistic self-reference at every stage of its history. So also with dislike and terror, hate and contempt. In sympathy, pity and mercy, an altruistic self-reference is involved, a reference to what Baldwin calls 'the bipolar self' in its unity of manifold selves. The consciousness of the identity of the private self with other selves, the sense of companionship and coöperation, is one of the profoundest joys of life, and it gives to public opinion all of its vast power to influence the conduct and the thoughts of men. Public spirit, that highest of the political virtues, is based upon it and involves it. Duty, obligation, self-approval, self-condemnation, remorse, and many other of the emotions and judgments of value whose objects are the private self and its conduct all involve feelings of harmony or discord between the private and the social self, or between one social self and another or others. These emotions are by all recognized as attributive elements in self-consciousness, which arise in experiences of particular persons and acts. There is no such thing as an emotion of duty in general, or of philanthropy toward mankind in general. What one commends, for example, is not charity, but charities; charity is the name for a particular social attitude or sentiment with reference to which one feels generality, and with reference to which one passes the judgment, 'charity is good.' The emotion which we experience with reference to charity in general is identical with the emotion present in all instances of conception, viz., an emotion or feeling of generality.

In the emotions of moral experience two closely related elements, a social and a private one, are present. A sense of personal worthiness or unworthiness to occupy one's place among his fellows, accompanied by an inner sense of discord, division and failure, or their opposites, as if I had injured or benefited myself by my own hand. One destroys his oneness with society and at the same time his oneness with himself, in his thought about himself, whenever he places himself under the ban of his own moral censure. The former, the sense of hagrin and defeat in the presence of one's fellows, is what is

meant by the loss of self-respect; the latter, the sense of disparity between one's actual self and that consistent and permanent self of one's faith and hope and love, is what we name conscience. The differentiæ of both kinds of feeling disappear as soon as we abstract the self-reference which they contain. Moreover, they are inseparable, and at times indistinguishable. The self of reflective consciousness is always a one-of-many, and the so-called unity of reflective consciousness is always a unity of one with many, a unity which the self has realized for itself by its own activities. The social consciousness is, in this sense, and in its form, bipolar, and whichever quality of moral experience one is conscious of, the cognitive content of self-consciousness is the same — only the point of emphasis, the focal point of attention differs.

Finally, the emotions of intellectual experience, emotions of wholeness or integrity, of generality, of necessity, and of particularity. In order that a society exist at all, there must be some medium of intercourse — gesture, cry, mimetic movement, or other. The consciousness of membership in any social group, whether immediate or reflective, will therefore be a consciousness of self (private or social) as a being who makes certain cries or other movements for the communication of thought; and, objectively, universality of significance among the members of the social group must attach to each gesture and cry before it can serve as a symbol for communicating thought and feeling. Here are the points of departure for the intellectual emotions of necessity and generality. Necessity, or the consciousness that the significance possessed by a certain symbol or series of symbols is demanded by the nature of the self of which we are conscious and by all selves of the same society, may be otherwise stated as a recognition of the necessity to society of attaching just that significance to that symbol. The 'theoretic ought' is rooted in this consciousness of social necessity. Universality, or the feeling-consciousness that what is true for one must be true for all selves, and the psychological dependence of my own conviction upon the consciousness that what seems true for me here and now is true, or will be found true, for all intelligent beings everywhere and always, is like-

wise a function of the social consciousness and inseparable from it. Integrity or wholeness in the objects of thought, likewise, is based upon the experience that other selves — that all selves, under the same conditions, must face the same object that I now face. Why should not the rocking-chair before me, like Faust's poodle, swell and contract, change into a hunch-backed beggar, or into a society swell all togged out with silk hat and cane? Why do children find no 'impossibility' in such stories as those of President Jordan to his children, about children who take off their legs at night with their clothes, the legs spending the hours when their owners are asleep in scampering out of the windows and in meeting all kinds of childish adventure? Why, if not because the child has only an implicit self-awareness, no consciousness of self as one of many, or as a unit whose very being is inseparable from certain forms of action and certain attributes of mind and body?

As the reflective social consciousness grows, the object, from being (1) a 'mere' object or external, becomes (2) a relatively permanent group of empirical properties common to the experiences of all selves with powers like mine, and (3) a 'substratum' of these properties, 'the permanent possibility of sensation,' a *Ding-an-sich*, independent of all private and particular selves. Hegel distinguishes these three uses of the word object, but he does not see that they are all functions of the social or self-consciousness, and that they appear in the individual's cognitive experience as he develops in reflection. The particular and the individual sustain just this genetic relation to each other: they are functions of successive stages of growth in the social consciousness, both being forms of what for want of a better term we may call the felt integral.

IX.

By way of recapitulation we may say, then, that thought and feeling cannot be separated or contrasted without destroying the reality of both. Thoughts are always shared experiences, while feelings are private and unshared; thoughts are always universal and, in reference, objective, while feelings are always particular and, in reference, subjective. Feeling is to

be regarded as an attributive element in self-consciousness, although self is not always explicit in consciousness and feelings are often read into the object and regarded as attributive there. In feeling, in other words, we experience immediately the relation of the ego to its object, a relation of unity or diversity which the ego itself establishes. The ego of which man is conscious cannot be a mere 'unconscious feeling,' or merely the state of the body, or the soul considered as a substance, but an activity whose product is a world of related selves and their experiences. As to the content of self-consciousness, we distinguished between immediate self-awareness and reflective self-consciousness. Self-consciousness in the first sense includes the empirical qualities of the body itself, together with a sense of externality to everything else within the range of perception or memory. Reflective self-consciousness is based upon the recognition that the self belongs in classes with other selves, that it is in a sense one with them, and that its experiences, therefore, possess a significance for them, and theirs for it. All feelings acquire a social reference, a universality of significance, from reflection, and thereby are transformed into ideal emotions which underlie æsthetics, ethics, the sciences of religion, and logic. The relational emotions cannot, however, be regarded as abstracts or genera to which other feelings are related as species. They are simply reflective, relational feelings which are immediately connected with the activities of the ego, particular feelings of particular activities. Relations obtain between the reflective functions of consciousness such that we may properly speak of the emotions of the logical processes and of volition, but I for one fail to find introspective evidence for the theory that there is an emotional logic of the emotions. I find nothing which seems adequately characterized as an emotional classification of the emotions.

DISCUSSION AND REPORTS.

DR. BOSANQUET ON 'IMITATION.'

Dr. Bosanquet's article in the July REVIEW, which summer work in California has prevented my considering for the September issue, is in my view a very valuable statement of the conditions of the problem before him and me, and a clear account of his own views. I find it, indeed, so able and fair that it would seem that our discussion should, before we finish, clear up some aspects of the problem of social organization. I endeavor in what follows to take up the threads as he used them, and to put into the garment a further stitch or two.

I find it well to preface the discussion proper with a personal explanation. It was not as a late or 'after' thought that I added—'at last,' as Dr. Bosanquet says—the theory of 'selective thinking' to my general explanation of social organization by the development of the 'imitative thought-situation.' On the contrary, the former topic seemed to me from the first an essential one; and the solution reached was printed in the *Social Interpretations*, first edition (Chap. III., on 'Invention,' § 3, 'Selective Thinking'). While the positions were explicitly taken there as now by me, the treatment was so brief that I chose the topic for expansion in the 'President's Address.'[1]

Considering some such theory, therefore, as Dr. Bosanquet also does, as essential to a genetic account of the psychological thought-situation involved in social life, I shall direct my remarks mainly to the last part of his paper, rather than to the early portion in which he criticises the 'imitation' view apparently without taking the theory of selective thinking into account. Yet, before proceeding to what I believe to be the really essential differences between Dr. Bosanquet's view and my own, certain remarks of his made in the earlier connection deserve notice.

First, I fully admit the requirement that a genetic theory should account for—so far as genetic theories 'account for' anything—what Dr. Bosanquet calls the logical or systematic character of thought, both in general and also in this particular case. I maintain the theory of selective thinking as such a genetic account. Indeed, it will be

[1] This address is now incorporated *in extenso* in the new volume, 'Development and Evolution,' Chap. XVII.

seen below that I find Dr. Bosanquet's failure to press such a genetic theory to its ultimate issue the main defect of his view. Accordingly, I am in no sense denying the 'logical' point of view, nor ignoring the facts of which it takes cognizance, in my attempt to supply a genetic theory. Here I think Dr. Bosanquet's account of my view, as based upon or requiring only 'repetition,' is liable to mislead. From the standpoint of scientific observation, and possibly also from that of analysis of content, imitations may be described as 'repetitions'; but that does not mean that repetition is a sufficient statement of the result in which the imitative functions issue. In the second part of this discussion I shall raise the general question as to the relation of imitative or repetitive mental contents to the form of 'logical' organization which involves them.[1]

The dispute as to the rival claims of 'resemblance,' on the one hand, and 'identity in difference,' on the other, seems to me so verbal and formal that time is not profitably employed in discussing it. It was for this reason that I failed to find a point of essential criticism in Dr. Bosanquet's former argument, where it was this distinction which was principally urged. Whether in biology we say, 'here are two individuals which resemble each other in this or that respect,' or 'here are two cases of the same identical character showing so much variation or difference,' is of little moment. The important matter is what use the scientist makes of the phenomenon thus alternatively described. I see the importance of the distinction from the point of view of a philosophy of individuality, and also from that of the logic of distinction and classification; but for empirical research I think the gain accrues from the emphasizing of differences, even to the extent of naming differently things which in some ways may show resemblance—as in the distinction between imitation and invention (to which Dr. Bosanquet objects) in current sociology. In my own theory, invention arises in imitations and is born of them, and there is a large mass of identical process in the two; but still, to the observer in sociology, the inventor is in type of performance, and in its effects upon the social body, as different from the typical imitator as a constructive thinker is from a parrot. Yet it may well be that I fail to catch Dr. Bosanquet's full meaning on this point.[2]

After these preliminaries I go at once into what I consider the

[1] The second part is to appear in the January issue. A request from the Carnegie Institution for advice in matters psychological delays the further writing.

[2] I confess I am not yet familiar with his biological criticisms made from this point of view.

essentials. Dr. Bosanquet makes two points—one an admission and the other a criticism—which sharpen the issue well; and what I have to say may be put under these two topics—in the reverse order of his argument. The first point is that as to the need and the extent of possible genetic analysis in this case; the second is that as to the adequacy of the imitative solution in the form of the 'self-thought' and 'selective thinking' theories.

I. In the first edition of my book I pointed out that thinkers of a certain class, whom I called 'idealists'—as holding to an 'ideal theory of social life'—'make the assumption of publicity.' "What is wanting," I go on to say ('Social Interp.,' 1st ed., 503), "is the bridge from the private thought to the public thought. * * * Given complex social situations, whence their validity for all the members of society equally, and whence the intrinsic element of public reference which is a necessity of social nature to us all? * * * They fail to describe the process or type of function by which the social matter becomes [or better, *is*] public, and is so made available for society and for the individual both at once" (pp. 504, 505). In my view it is the imitative process of assimilation and growth which supplies this requirement—the requirement that we depict what actually occurs in the genetic progress of consciousness in thinking a 'public' thought.

Now it is extremely interesting to me that Dr. Bosanquet explicitly admits that he makes this assumption. Speaking of the individual's 'grasp of the relation between the persons involved,' he says, "I do not see the initial difficulty of obtaining such a grasp, which is a condition of the general will or self. It is implied in mental process from the first, through the principle that contents operate as universals, assuming differences in accordance with the details through which they are reproduced. As regards the participation of different intelligent individuals in one such grasp, the true principle seems to me to be that an idea normally operates throughout several intelligences just as within one. * * * I mean that, in all cases the ultimate nerve of intercourse is that according to a nature common to all concerned, one thing follows from another. * * * The thing so following, whether in myself or in another, I equally recognize as the continuation and completion of my thought. * * * The nerve of the whole process is that, given the data, including their own resources, other minds bring out, in a form prescribed by their powers, the conclusion at which mine is aiming. The point is, that it is a *conclusion*"—communication depends ultimately on logic (PSYCHOL. REVIEW, July, 1902, pp. 385, 386).

Here the issue is clearly joined: shall we assume, at a stroke, so-

cial organization through a number of minds acting—thinking—alike on the same material, or shall we ask by what type of actual social experience they accomplish this? The latter inquiry, as I conduct it, simply aims to discover the normal vehicle of what Dr. Bosanquet properly calls the 'normal' operation of the mind. Suppose we admit the 'principle that contents operate as universals'—a phrase itself obscure enough, indeed—still there must be concrete images, objects, thoughts, processes, which body forth, as it were, the 'universals' and show the 'operation.'[1] I suppose that Dr. Bosanquet would hold that there is some mental function—say sensation—and some 'logical' process (in his sense)—say my castles in Spain, or my solution of the coal-strike problem—which I do not hold others to; constructions which are tentative, personal to me, not of social value, or *not yet* so. Now I ask what further function, psychic process, does give social value to some 'logical' constructions and mark their public character. I hold that whatever is a process, whatever 'operates,' whatever we can attribute to consciousness, *must show itself in some sort of empirical movement.*

The same sort of claim in kind, as that of Dr. Bosanquet here, is made—to cite other instances in current discussion—by those who say that the 'self' may be assumed with no sort of scientifically observed empirical process of growth and determination in actual consciousness; and Professor Ward seems to hold that while 'mental activity' is discoverable, still no particular type of changes of content can be pointed out as revealing it. This sort of claim is, in all these instances, I think, sheer mysticism. Whatever is, *shows.*[2]

Now, in fact, in my own answer to the question I reach a process which would seem to be general[3] enough to please anybody—that of the rise of self-consciousness by functions which normally implicate other selves; and I hold that there is here the normal operation of the processes involved in the 'grasp' which Dr. Bosanquet speaks of.

But this is not the only point at which Dr. Bosanquet makes, as he himself allows, an assumption—one which sets limits to the genetic point of view. He assumes the so-called 'logical process,' or

[1] Unless we postulate a real general or universal self or will whose nature it is just to 'come to itself'—as I say in my book—in individuals in essential independence of the actual experiences of their mental lives.

[2] The question of mental constitution or endowment is, of course, a legitimate one, and certain 'characters' of mind, such as 'laws of thought,' etc., may be taken up from the point of view of racial evolution (see the second part of this discussion in the January issue).

[3] I avoid the term 'universal'—only trained philosophers are 'sure' in their meaning of it!

the 'organization of thoughts' and their progressive determination. He says, "selective thinking is an improper phrase, because thinking as such is selective and more than selective, being selective, so to speak, by construction of determinate variations. Professor Baldwin has a leaning toward determinate variations. I believe that this is the crux of the whole matter, and that if the origin of determinate variations be fairly considered the idea of selective thinking must go" (*loc. cit.*, p. 388). This is simply and frankly to say that no possible tracing of the genetic process of organization of thoughts in 'logical,' or better 'systematic,' wholes is possible. Now my reply repeats the point just made above. I say, suppose it be true that all thinking is selective, still genetic science has to ask how selection works. Why are some thoughts[1] selected, while others are not. What function is *par excellence that in which selection occurs?* Why one particular line of determination at one time, at another time, another? Why is thought determined differentially, preferentially, polytypically? If one simply calls a halt and says, there is no answer to these questions, for the simple matter is that the mind, for no reasons and by no regular processes, makes its truth what it will, showing no process of tentative experience, of trial and error, etc., then well and good; then that is the end of discussion. But to me it is to go back to the essential mysticism of the *a priori* formalism which prevailed before the rise of the genetic point of view. The same question vexes the soul of the biologist: the assertion of 'determinate variations,' in the narrow sense of the claim that no natural reasons can be given for whatever balance of variations may be found in a given direction, and consequently that since science cannot account for them they are part of the inner character—the mystery—of life. This, I believe, in biology as in psychology, is a resort to what is called above sheer mysticism.[2]

[1] Broadly defined, as 'cognitive wholes,' or 'mental objects' (cf. Stout's definition of 'object' in my *Dict. of Philos. and Psychol.*, Vol. II.).

[2] Dr. Bosanquet cites a passage in which I say that new inventions are always variations from functions already attained—variations from what, in the address on 'Selective Thinking,' I called a 'platform.' This is very different from saying that the variations are themselves determinate, that is, that more than the probable number lie in any particular direction. Determinate variations in biology would imply an uneven distribution of cases about a mean, apart altogether from the relative position of the platform from which the whole series of them is projected. I have pointed out, in *Development and Evolution*, p. 160 ff., the common confusion that prevails on this point. Any scheme of thought variations is on a platform; but my personal opinion, based on the exact statistical researches now available, is that they are themselves indeterminate, and that just for this reason a process of selection is necessary as in biology.

I think with Dr. Bosanquet that this is the 'crux' of the whole matter: is there some intrinsic principle of determination which does not show itself in any recognizable conscious process of growth? If so, then no genetic account of it can be given. I believe that both here and in biology nature works by phenomenal changes, and by constant laws, and that nowhere, at no point in the backward regression of events, can science stop and say, beyond this there is a something, it is true, which issues in determinate phenomenal organization of contents, but which is itself not observable as change in content. So if Dr. Bosanquet really does *give up the task of showing* how selective thinking works, and make it simply an assumption, then I don't see how the 'crux' between him and me is to be overcome. It follows, too, and of course, that if no account can be given of the selective character of thought, then the account of it in terms of imitation and selection—my account of it—is ruled out. And I count it one of the services of his article to have stated this issue—in terms to which we both subscribe—for the interested reader. The remarks on the origin and meaning of 'truth,' in my chapter on 'Selective Thinking,' join the issue in about the same way.

II. But seeing that Dr. Bosanquet does discuss the theory and does bring certain specific objections to it—besides the general one that any such genetic account is impossible—I shall reply, as far as I can, to his criticisms. In the first place, it will be seen from what is said above, that I do not allow that the alternatives read *imitation plus selection*, OR *organization* (his 'logic'); but, admitting the organization, I hold that it is a question of *organization by a process of imitation plus selection*, OR *by some other genetic conscious process.* I am not able to stop anywhere and say, here no further genetic process can be traced and so much organization as here exists must be flatly assumed.[1] The scientific spirit of enquiry may be at points permanently baffled, but it does not admit miracles!

So, claiming the legitimacy of some genetic account of the process of organization—what I have called 'systematic determination'[2]—the

[1] In remarking that Dr. Stout seemed to me to be tending toward a theory of selection, I did not mean that he was in any sense giving up his doctrine of thinking by organization in a logical 'plan of the whole.' I myself go a great way with Dr. Stout and with Dr. Bosanquet in this doctrine; but I meant that Dr. Stout seemed to admit the legitimacy of finding a genetic account of the method of growth of such logical or teleological wholes. My impression is based largely on personal conferences with Dr. Stout in connection with our work for the *Dictionary of Philosophy and Psychology.*

[2] *Development and Evolution*, chap. XVII.

narrower question is: can we say that the imitative self-thought theory combined with the selective thinking theory is a valid account of the case of organization which we describe as social thinking ?

Dr. Bosanquet seems to admit—what I think a careful reading of his discussion will bear out—that much of his criticism of the social imitation theory would be met in case the theory of selective thinking were made out. I shall accordingly take up in the next issue, if possible, his objections to this latter theory.

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METHODS OF TESTING RELATIVE PITCH.

A comparison of the methods that have been used for testing perception of pitch is of importance, as the results that have been obtained vary considerably.

In the *Yale Psychological Laboratory Studies*, 1893, I., p. 80, Gilbert reports experiments on the 'Musical Sensitiveness of School Children.' These experiments were confined to testing perception of pitch differences. A pipe was used by which the experimenter produced tones separated by $\frac{1}{32}$ of a tone, or multiples of that amount. The apparatus is described fully in his paper. The method of gradation was used. Starting from notes a considerable distance apart, the experimenter made the difference less until the subject declared that he perceived them as the same. The process was reversed and the average of the two results taken. An average of ten such experiments with each child was taken. The results indicated that children of six years could, on the average, discriminate tones $\frac{1}{32}$ of a tone apart, and that the improvement was fairly uniform to the age of 19, at which age a difference of $\frac{3}{32}$ of a tone was, on the average, perceived.

In employing the method of gradation with a string instrument I encountered the serious objection that a hypercritical attitude, either constitutional or suggested, on the part of the subject works constantly for a better, the opposite attitude for a worse record. That is, a person who fancies he notes differences where there are none perceptible by him, or confuses quality or intensity differences with pitch difference, secures a better average than one who records more accurately what his senses give him. By the method of right and wrong cases this difficulty may be avoided. Differences of quality and intensity are very likely to arise in any pipe instrument, especially when the mouth is used. Moreover, as by this method the difference in pitch con-

tinually varies, the subject is poorly provided with a standard difference with which he may compare, and from which he might distinguish qualitative differences. From Table II. it may be seen that this is important. The best subjects show their superiority in perceiving notes of the same pitch as the same. The poorer subjects tend to call all notes different, confusing qualitative with pitch differences. A further objection to this method is its length.

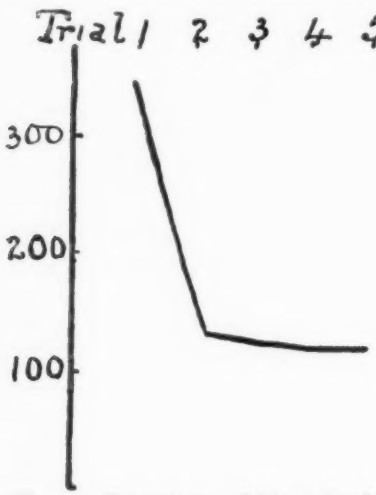

FIG. 1. Percentage of Mean Deviation of Successive Trials.

In testing freshmen and seniors for perception of pitch, the Psychological Laboratory of Columbia University uses a wire, 1 meter long between supports, with a movable bridge. A note is given with the bridge at 750 mm. from one end (giving F_1), the bridge is placed at the center, and the subject tries to reproduce the tone given. Then the original tone is again given, the bridge is placed where the subject left it, and he tries again. The average of the two results is taken. The weakness of this experiment is that the tone memory is tested as well as the tone perception; this is only partly remedied by replacing the bridge for the second trial where the subject had left it at the first trial. It is not claimed that the results are more than approximate and relative. Of those tried, 10 per cent. have an error of less than .1 of a tone; 53 per cent. .1 to 1 tone, and 37 per cent. more than one tone. These errors are far greater than those of school children tested by Gilbert and by me.

In examining the Columbia Laboratory method I prolonged it to ten trials, always replacing the bridge for each trial where the subject had left it at the preceding trial. I made fifteen such experiments. For each subject I computed the mean deviation, brought it to a fraction of the average error of that subject, to make it comparable with other cases, and took an average of the resulting fractions. The average deviation was .706 of the average error, which shows a large element of chance. In a similar manner I found what fraction the average deviation of the first, second, third, fourth and fifth trials were of the average deviation of the last nine trials in each experi-

ment (see Fig. 1). It is clear that the first trial is not comparable with the others. As I also found that the first trial gave an error far greater than the remaining trials, and the second trial one considerably greater, the average of these two trials indicates a perception of pitch far worse than that actually possessed. However great a number of trials is taken, this method is open to a further objection. A subject may by chance get within his power of discrimination and may remain there, for there is no apparent reason why he should move the bridge further away from the correct place (see Fig. 2). All the records on this figure were made by the same subject.

For these reasons neither Gilbert's method nor that in use at Columbia seem very satisfactory for anything like an absolute determination of pitch perception. To secure necessary thoroughness without too great expenditure of time we must look, I think, to methods suitable to use with classes. An individual test, however, is sometimes valuable to confirm the class test. The method of 'right and wrong cases,' in which the operator produces the tones, is too long. The subject must reproduce the tone therefore. This may be done by the voice: but in the absence of any practical phonautograph an accurate test of pitch perception cannot be obtained in this way. All wind instruments, it seems to me, interfere with the memory of sound because of the continued and varying note given during adjustment. Those that require the use of the mouth interfere with the subject's attention, and have other faults.

As an improvement on the Columbia method above described I suggest the following: Use two strings, 1 meter long, the tension being adjusted so that the note given by one is equivalent to that given by the other when the bridge is placed, say, 750 mm. from one end. Within an octave of middle C, any note that can be readily checked with a tuning fork will do. The bridge should be just as high as the wire. The movable bridge should slide in a groove, and should clamp the wires with wooden surfaces pressed together by a spring. The subject should face the instrument and handle the movable bridge until he can move it without special attention to it, and until he understands what effect on pitch motion in either direction has. The purpose of using two strings and this kind of bridge is to save time, confusion and distraction of attention, all of which introduce the question of tone memory into the experiment, which is, of course, an entirely different matter from tone perception.

The bridge is put at the center of the one string and the standard note is given on the other. This the subject tries to reproduce. When he stops, the standard note is given again, and the subject tries

again. The result of the second try is recorded for averaging. For a second experiment the standard note may be changed by placing the bridge at, say, 800 mm. from one end of the standard string, which would be equivalent to 600 mm. on the string which the subject uses. The error at the second attempt is noted, corrected by being multiplied by $\frac{5}{4}$, and averaged with the first record. The average can

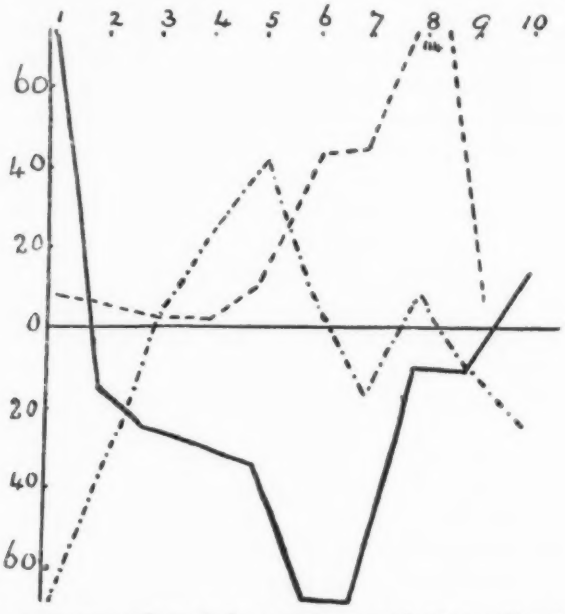

FIG. 2. Three records made by a graduate student according to Columbia method. The ordinates show the errors in mm.

easily be reduced to fractions of a tone. These two tests can readily be carried out in five minutes with the average scholar.

Working with a rather poor instrument I found that, in 72 trials, the mean deviation was thus reduced to .48 of the average error, as contrasted with .706 by the present Columbia method.

I think that methods suited for use with a class are better. I first used tuning forks that gave respectively 512 and 516 double vibrations per second. By adding wax I could get intervals of $\frac{1}{6}$, $\frac{1}{14}$ and $\frac{1}{28}$ of a tone, without causing thereby any marked differences in quality between the forks owing to the mass of wax on either of them. To find what interval people capable of musical training possess, I secured the coöperation of a 'mixed' church choir, and of the ladies of two of Professor Farnsworth's classes at Teachers College. Pro-

fessor Farnsworth and the choirmaster kindly graded the subjects into classes 'a,' 'b,' and 'c,' according to musical ability.

I first required the subjects to say which of two notes given was higher. The results are given in Table I. They show that musical

TABLE I.

Interval	$\frac{1}{6}$	$\frac{1}{14}$	$\frac{1}{28}$ tone.			
No. of trials	10	20	10			
Class *a*	95.7	63.5	58	per cent.	right.	14 subjects.
" *b*	69	48	37	"	"	9 "
" *c*	50	65	54	"	"	8 "
Unclassified	70	55	49	"	"	8 "

ability corresponds rather closely to capacity to perceive pitch differences. Further, that by this method an interval of $\frac{1}{6}$ tone is probably a little too small for eliminating those that are incapable of musical training. Some of the better musicians showed a tendency to call the lower notes the higher, and conversely, at every trial, a fact that obviously discredits this method.

I then required the same classes to tell whether the tones given on the forks were the same or different. Table II. shows the results.

TABLE II.

Interval	$\frac{1}{6}$			$\frac{1}{14}$			$\frac{1}{28}$ tone.		
No. of trials	20			30			20		
	'Same.'	'Different.'	Total.	'Same.'	'Different.'	Total.	'Same.'	'Different.'	Total.
Class *a*	80	85	83.3	67.7	61.7	64.7	75	61.7	70.7
" *b*	71.4	90	83	61	72.4	68	61.6	70	66
" *c*	66	96	81.5	68	81.3	74.7	56	56	56
Unclassified	33.3	100	66.6	50	63.3	56.7	13.3	66.3	40

The numbers indicate the per cent. of answers right.

The words 'same,' 'different,' there indicate that the per cent. given below is the number of right answers given when the tones struck were the same or different. An equal number of each was given in the experiments. It is clear from these figures that when the subject begins to get uncertain, his difficulty is usually not so much in perceiving that the tones are different when they are different, as in telling that the same notes have been struck, *i. e.*, in distinguishing qualitative from pitch differences, or, perhaps, in checking his imagination.

In the use of the last method I judged that $\frac{1}{6}$ tone is too small a difference to select the best ears, too large to indicate the really deficient ones. I therefore selected $\frac{1}{8}$ tone and $\frac{1}{9}$ tone as the intervals for

a series of tests with school children. As I could not get suitable tuning forks I strung two wires so as to give the same note for their full length, namely middle C, and, by means of a bridge, secured the above intervals. I gave twenty trials at each interval, in alternate series of ten each, making the number of 'sames' and 'differents' equal. Tables III. and IV. and Fig. 3 show the results. I cannot

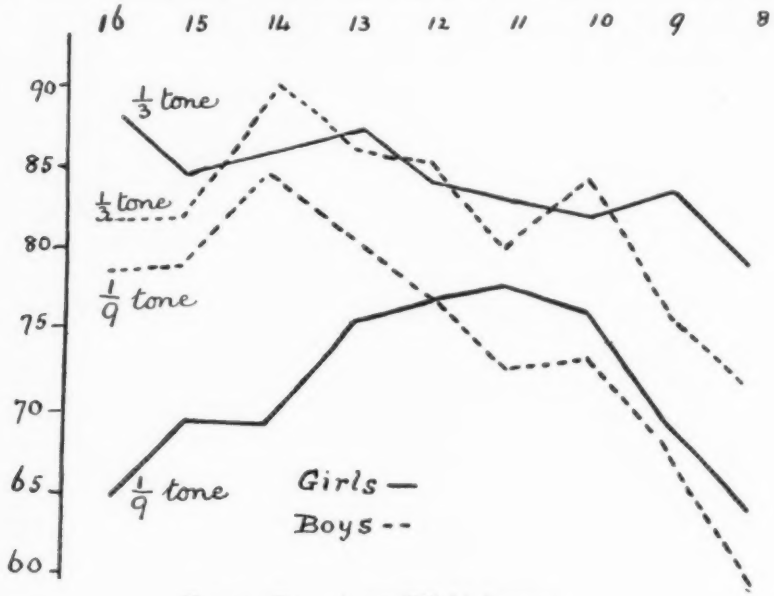

FIG. 3. Percentage of Right Answers.

TABLE III.

PERCENTAGE OF SUBJECTS FAILING TO GET MORE THAN 75 PER CENT. RIGHT.

Age in years	16	15	14	13	12	11	10	9	8
Number of subjects	5	17	28	41	27	30	29	33	17
Girls, $\frac{1}{3}$ tone	0	23	18	15	19	33	34	34	35
Girls, $\frac{1}{9}$ tone	100	76	68	66	52	50	58	90	95
Age in years	16	15	14	13	12	11	10	9	8
Number of subjects	5	10	28	41	27	30	29	33	17
Boys, $\frac{1}{3}$ tone	40	30	7	20	23	35	29	50	60
Boys, $\frac{1}{9}$ tone	20	50	25	35	48	58	50	80	80

TABLE IV.

PERCENTAGE OF CORRECT ANSWERS.

Age	16	15	14	13	12	11	10	9	8
$\frac{1}{3}$ tone	86	84	88	88	85	82	84	78	75
$\frac{1}{9}$ tone	72	73·5	77·5	78·7	77	75	75	68	59

explain the poorer showing of the older girls with the small interval as shown by the curve. Younger girls did better at the same time under the same circumstances.

I examined the papers, taken at random, of thirty-five boys and girls, and found the same tendency as in the former experiment to err chiefly in telling which notes were the same. Out of 308 errors in 1,400 answers: 178, or 57.8 %, were 'same' called different; 130, or 42.2 %, were 'different' called same; in conducting the experiment the instrument was kept from view, one or more teachers watched with me for any signs of copying or prompting, and, especially, I was careful to get the interest of the children in securing correct results. The first note must be dampened before the second is sounded, so as to prevent beats. Great care must be used to strike the string at the same distance from the ends and in just the same way.

The fact that the subjects discriminated an interval of one third tone not much better than one of one ninth tone may, perhaps, be taken to indicate that the growth in accuracy is a matter of cerebral more than of aural development. Another indication in this direction is that the older children in a class, who are more likely to be 'left backs' did rather worse than the rest of the class, as a rule.

Two or three of the teachers remarked on the apparent connection between general intellectual inferiority and inferiority according to these tests.

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PSYCHOLOGICAL LITERATURE.

NEUROLOGY.

Die Abhängigkeit des Hirngewichtes von dem Körpergewicht und den geistigen Fähigkeiten. OTTO SNELL. Arch. f. Psychiatrie, Bd. XXIII., 1892, S. 436–446.

Ueber die Abhängigkeit des Hirngewichtes von der Körpergrösse bei den Säugethieren. EUGEN DUBOIS. Archiv f. Anthropologie, Bd. XXV., S. 1–27.

Ueber die Abhängigkeit des Hirngewichtes von der Körpergrösse beim Menschen. EUGEN DUBOIS. Archiv f. Anthropologie, Bd. XXV., 1898.

On a Formula for Determining the Weight of the Central Nervous System of the Frog from the Weight and Length of the Entire Body. H. H. DONALDSON. Decennial Publications of the University of Chicago, Vol. X., 1902. Pp. 12.

On the Mitosis in Nerve Cells of the Cerebellar Cortex of Fœtal Cats. S. HATAI. Journal of Comparative Neurology, Vol. XI., No. 4, 1901.

On the Presence of the Centrosome in Certain Nerve Cells of the White Rat. S. HATAI. Journal of Comparative Neurology, Vol. XI., 1901.

The Division of Differentiated Cells in the Central Nervous System of the White Rat. ALICE HAMILTON. Journal of Comparative Neurology, Vol. XI., No. 4, 1901.

Observations on the Developing Neurones of the Cerebral Cortex of Fœtal Cats. S. HATAI. Journal of Comparative Neurology, Vol. XII., No. 2, 1902.

Number and Size of the Spinal Ganglion Cells and Dorsal Root Fibers in the White Rat at Different Ages. S. HATAI. Journal of Comparative Neurology, Vol. XII., No. 2, June, 1902.

Address of the President of the Anthropological Section of the British Association for the Advancement of Science. D. J. CUNNINGHAM. Science, N. S., Vol. XIV., Nos. 355, 356, Oct. 18 and 25, 1901.

In any animal which possesses a nervous system it should be possible to determine the amount of substance which has been differ-

entiated into nerve tissue and to compare this amount with that of any or all the tissues that form the remainder of the body. Owing to the mechanical difficulties which stand in the way of dissecting out the entire peripheral nervous system in any animal, and the spinal cord in the larger animals, it has come about that in vertebrates the encephalon has been, for the most part, the only portion of the nervous system measured with sufficient care to permit of comparisons. Of course the weight of the encephalon is by no means a constant fraction of the weight of the entire nervous system, nor is the proportion of the active nerve substance proper—that forming the neurones as contrasted with the medullary sheaths and the non-nervous portion of the encephalon—similar in the encephala of different species of vertebrates. Nevertheless, despite departures from uniformity and the limitations following a comparison of the encephala alone, a study of the weight relations of the encephalon in several classes of vertebrates leads to suggestive conclusions.

For more than a century, anatomists have been in search of an explanation for the observed fact that, even within the limits of a given order or genus of mammals, the weight of the encephalon did not increase in proportion to the weight of the entire animal, but was represented by a fraction which became progressively smaller as the body-weight of the species became greater. This rough statement of these relations was the best available when Snell published his observations in 1892. For his purpose he distinguishes two relations of the nervous system—represented by the encephalon—with which variations in weight might fairly be correlated. The first of these is the relation of the encephalon to all the metabolic activities of body—and the second, the relation of the encephalon to the psychical activities of the animal. In a general way, the larger the mass of the animal undergoing metabolic changes, the larger will be the amount of nerve tissue required, and also, within the limitations of class and order, the more complex the psychological activities of the animal the greater the mass of the encephalon.

Regarding these relations of the nervous system as factors in determining its mass, Snell designates the former as the 'somatic factor,' and the latter as the 'psychic factor.'

Beginning with the 'somatic factor,' he states the general proposition based on studies in metabolism, that the amount of metabolic change in animals of like form but different body-weight, is proportional to the extent of the body-surface, and not to the body-weight. In order to get this relation into a mathematical form, he defines

animals of like form as those having similar geometrical figures, the surfaces of which are therefore proportional to the squares of their respective diameters, and the volumes, to the cubes. It is further assumed that the specific gravities of the several encephala to be compared are so nearly alike that the relations between their weights are identical with the relations between their volumes. Hence it is possible to translate weight relations into volume relations directly.

Under these conditions, if it is desired to compare the development of the encephalon as represented by its weight in two animals of approximately like psychical abilities and similar form, but differing in body-weight, as, for example, a mouse and a rat, it would follow, according to Snell, that their brain weight would stand in the same relation as do the areas of their bodies. Thus if a represent the body-weight of the mouse and b that of the rat, and the weights as above stated stand in the same relations as the volumes of the bodies, then $\sqrt[3]{a}$, and $\sqrt[3]{b}$ will give comparable diameters of the bodies and the squares of these diameters expressed thus:

$$(\sqrt[3]{a})^2, (\sqrt[3]{b})^2$$

will be related as the areas of the bodies or as their surfaces. If h and h_1 represent the weights of the encephala for mouse and rat in the order named, then

$$h : h_1 :: (\sqrt[3]{a})^2 : (\sqrt[3]{b})^2$$

Taking the square of the cube root of the body-weight is equivalent to raising it to the 2/3 power or expressed decimally the 0.666 power.

The former may then be written: $h : h_1 :: a^{0.666} : b^{0.666}$. This exponent (0.666) is thought by Snell to be probably too small for mammals, and he proposes 0.68, which is slightly larger, as the better value for the 'somatic exponent.' In Snell's article, there is no evidence that he tested the validity of the conclusion here reached, but assuming that it was valid, he passed at once to a determination of the 'psychic factor,' or that difference in the weight of the encephalon which was to be correlated with the psychic development of the animal.

His procedure may be exemplified as follows: It is desired to compare the weight of the encephala of the mouse and of man. If the total weight in each case is the product of the somatic and psychic factors into the body weights, then b being the body-weight of mouse, and c that of man, and p and p_1, being the respective 'psychic factors,' it follows that the weight relations of the two encephala will be as $p.b^{0.68} : p_1 c^{0.68}$.

In any instance where the brain-weight is known, therefore, a division of the brain-weight by body-weight raised to the 0.68 power will give the number designated by Snell as the 'psychic factor.' If, now, animals for which the psychic factor has been found be arranged in a series determined by a diminishing value of the 'psychic factor,' it is found that the order in which the animals appear in this series is very close to the order in which they would be arranged were their psychical abilities determined by direct observation.

For example, by this method man leads the list with a psychic factor of 0.874 and a relative brain-weight (*i. e.*, the relation of the weight of the encephalon to that of the body) of 1/35, whereas the field mouse is down towards the end of the list with a psychic factor of only 0.045, though the relative brain is nearly the same, being 1/37.

In other words, due allowance being made for the relations of the encephalon to general metabolism, the psychical abilities of vertebrates are closely correlated with the weight of the encephalon.

This problem of the relation of the weight of the brain to the size of the body in mammals was taken up again by Eugen Dubois in 1898. Dubois discusses the differences in functional activity between animals of like form but differing in size, also the differences in the arrangement of the nervous system so far as they depend on size. He then proceeds to render Snell's formula more precise and to test thoroughly its applicability, using for the purpose Weber's records (1897) of the brain- and body-weights of mammals—the most reliable and complete catalogue thus far published. In taking up the subject Dubois starts with the propositions: First, that two animals of the same body-weight differ in brain-weight according to their position in the zoölogical scale; and second, that in the case of two animals having the same grade of brain organization, the animal having the greater body-weight will also have the greater brain weight. The weight of the encephalon depends therefore on (1) the degree of cephalization and (2) on the weight of the body. Dubois then makes a definite advance by pointing out the connection between the area of the surface of the body and the increase in the number of sensory or afferent nerve fibers by which this surface is innervated. If the arrangement of the nervous system is viewed further from the standpoint of segmentation, and each segment of the body considered as innervated by a sensori-motor mechanism, these segmental mechanisms being joined by the connecting tracts which constitute the bulk of the central nervous system, then, on comparing two animals of different body-weights but of the same grade of organization, it is impossible to

picture the differences as depending in the first instance on the development of the sensori-motor mechanisms for each segment, which increase in weight in proportion to the increase in the skin area to which they belong, and since the grade of the two animals compared is the same, the central tracts uniting the segmental mechanisms are also proportionately increased. Since the encephalon is in the main merely a complex of such uniting tracts, they would consequently increase in weight in proportion to the increase in the area of the body surface, and there would follow the increase in encephalic weight according to the hypothesis of Snell.

It is evident, however, that the analysis of the sensori-motor segmental mechanism can be carried much further.

In the first place it has been assumed that the constituent elements in the animals compared are alike in size, and that the larger area of the larger animal would be innervated by a proportionately larger number of fibers each having the same area in cross section as in the case of the smaller animal. Again, in the larger animal, it has been assumed that the increase in the other areas supplied by nerves is the same as that which occurs in the skin—but perhaps the point which it is most necessary to determine is whether the sensory innervation in the larger animal is of the same density as in the small. Taking the retina as a guide, Dubois argues that since the retina becomes relatively diminished in the larger animals, it is probable that the other sensory supply to the surface behaves in the same way, and that as a consequence, the sensory surface of the larger animals is less densely innervated than we should expect to find it by Snell's hypothesis; as the result of this, the connecting tracts in the central system would be relatively less numerous and of smaller weight and the encephalon of the larger animal therefore have a smaller weight than the theory demanded.

On the efferent side of the reflex mechanism, the relation between the increase in the weight of the muscles and the number and size of the nerves innervating them still offers a number of unsettled points. It appears probable that the increased nerve supply to the larger muscles depends rather on the relative increase in the area of the cross section of the muscles than on any other change.

However, the effects of alterations in this part of the arc are probably of least influence on the weight of the encephalon, and a much more important factor is to be found in physical features of the cerebral cortex and the formation of gyri in the encephalon. Dubois states that in the encephalon of mammals the cortex has nearly the same

thickness, no matter what the size of the animal. This is probably an over-statement of the small variability of this layer.

Nevertheless, it is true enough to direct attention to the source of a real difference between the brains of large and small animals having the same form, since the failure of the cortex in the larger animal to increase proportionately in thickness necessitates an extra increase in area, thus causing a folding and a formation of gyri, and a brain with gyri is smaller and weighs less than a brain composed of the same number of elements and equally complex would weigh were the cortex not folded.

The foregoing paragraphs serve to show the way in which the relations between the encephalon of the small and that of the large animal of the same zoölogical grade have been analyzed by Dubois. As the result of such an analysis, Dubois was led to anticipate that the weight of the encephalon would increase more slowly than the formula of Snell demanded. This Dubois tested by determining the 'somatic exponent,' or, as he prefers to name it, the 'exponent of relation,' for some seven pairs of mammals, selected from Weber's list. Here the weight of the body as well as the weight of the encephalon is given in each case, and the value of r, the 'exponent of relation,' is worked out. The seven values of r range between 0.5412 and 0.5854, the average of all seven being 0.5613. It will be seen that this is decidedly less than the value of 0.68 finally adopted by Snell. The smaller value found by Dubois is accounted for by considering that one or all of the factors which tend to make the difference in the weight of encephala relatively smaller than that in the area of the body, have been active in these cases. In one group, namely, the bats, where the change in size is not very great and is accompanied by the least modification in the enlargement of the encephalon, the increase in the weight of encephalon has been nearly proportional to the increase in the area of the body, and the value of r is 0.6649, which is practically Snell's theoretical value. It appears from this that the enlargement of the encephalon in the larger animal is certainly modified by the conditions which have been named, and probably it is further modified by conditions touching the finer structure of the encephalon — the data for which are not yet available.

Passing next to the 'psychic factor' of Snell, we find this represented by what Dubois calls his 'exponent of cephalization,' a term much to be preferred to that of Snell.

The 'exponent of cephalization' is represented by a number which, when multiplied by the weight of the animal raised to the

rth power, gives a product which is related to another product obtained by the same process, as are the respective encephalic weights of the two animals compared. Expressing this in a formula and using the same symbols which Dubois employs, we have:

$$E : e :: C.S^r : c.s^r$$

where E is the weight of the encephalon in the large, and e that in the small animal; S and s, the body weights, and C and c the 'factors of cephalization' for the same large and small animals, the weights of whose encephala are given.

It is thus possible to arrange animals in a series according to their 'cephalization exponents,' and the position in that series is found to correspond closely with the degree of psychical development exhibited by the living animal. There are limitations to the use of the 'factor of cephalization,' however, and it must always be remembered that in the first instance it is based on weight only, while there are ways in which the complexity of the encephalon and its physiological efficiency can be altered without necessarily causing any corresponding alteration in its mass.

By this investigation Dubois has made a most noteworthy contribution to our knowledge of the comparative anatomy of the nervous system. By correlating the skin area and the nerve supply to it, and then the development of the remainder of the system in relation to this afferent division supplying the skin, the changes in the mass of the central system are anatomically linked with those occurring in the rest of the body. It may be fairly said that now we can explain why the brain in large animals increases in weight so much less rapidly than does the body.

On the way to his general conclusion the author has entered a very large number of queries concerning possible differences which may exist between the brains of different animals, and the attempt to find answers to the questions should stimulate much important work. Of course, as the amount of metabolic activity varies with the area of the body surface, there is an indirect correlation between the metabolic activity and the weight of the central system, but it would appear more probable that the increase in the weight of the nervous system in larger animals was not dependent on the fact that the metabolic changes in them were greater and needed the increase in nerve tissue to control them, but because each new area of skin required to be innervated, and with the introduction of the new afferent elements other elements in the central and efferent systems were necessarily

added in order to complete the connections over which the additional impulses must pass. We thus come to view the increase in the mass of the central system as correlated with an increase in the number of afferent elements composing its sensory side, the increase of the other parts following in an orderly way its expansion at the periphery. Encouraged by this work on mammals, Dubois went forward to see whether an 'exponent of relation' could be determined when the brain-weights of men having different body-weights were compared. As the determination of the proper body-weight and stature depends on measurements taken on men in full health and at the prime of life, it was manifestly impossible to obtain the brain-weights of the same series. Through the kindness of his friend Herr Otto Ammon, he was able to measure four groups of young healthy men (inhabitants of Baden) who were classed as very tall, tall, medium and short. The group of very short persons was lacking. Below is given a part of his table for these four groups, each group containing 10 persons.

Group.	Stature. Cm.	Sitting Height. Cm.	Body Weight. Kgms.
1	177.4	91.7	72.74
2	171.9	89.9	67.49
3	165.7	87.7	60.11
4	159.5	85.05	55.50

In addition to the measurements exhibited above, the length and breadth of the head were taken and by the aid of formulæ and data derived from the results of Welcker and others, a calculation of the probable brain-weights for this series of men was made. This gave a series of four average brain-weights corresponding to the four groups, any one of which weights could be compared with all the others. Six comparisons could thus be made and the value of r the 'exponent of relation' determined in each instance.

In this series it was found to range between 0.1607 and 0.3978, with an average of 0.2586. There is evidence that the limiting values above given are excessive, and that with more numerous data the values approximate 0.25. Dubois, therefore, takes 0.25 for the value of r. If, then, we compare two groups of men (in this instance, males of the same race and locality) with one another, with a view to determining their relative brain-weights we find the relation can be expressed by the formula:

$$E : e :: S^{0.25} : s^{0.25} \text{ or } \sqrt[4]{S} : \sqrt[4]{s}$$

where the brain-weight of the heavier group is represented by E and

that of the lighter group by e, while S and s represent the body-weights of the heavier and lighter groups respectively.

The formula indicates that the increase in the brain-weights is in the same ratio as the fourth roots of the body-weights. This result is most interesting in itself, for by means of it we are able to replace the older and more general statement that among men the taller and heavier persons have on the average heavier brains, by the above formula, which expresses the law according to which the brain-weight increases. It is important to note that satisfactory data for testing this relation are extremely difficult to obtain, even under the most favorable circumstances, and for this reason it will probably be some time before it can be decided whether the same exponent of relation holds among women, or when the two sexes of the same race or different races from widely different localities are compared.

Yet, despite the limitations which are at once recognized, this determination by Dubois is an important discovery. One naturally asks why among men the increase in the weight of the brain in correlation with the body-weight, is so much slower than in the other mammals of different sizes which have been studied in connection with this problem. It can be said at once that in all probability the increase in the volume of the cranial cavity must take place according to this same law, and that, so far as the modifications of the nervous system are concerned, the larger individuals would appear to stretch the existing nerve-supply as the body became greater, rather than to add a proportional number of new elements for each new unit of area.

In this same paper Dubois examined the relation between the brain-weight and stature. A test of the data just employed shows that the groups increase in stature more rapidly than does the brain-weight. If, however, instead of the entire stature the sitting height be taken, Dubois finds that on the average the brain increases in weight in the same proportion as does the sitting height, a most simple relation, and one which Dubois regards as very important. If we may comment on this result, it would point in our opinion still more strongly to the explanation given earlier for the slow increase in brain-weight in taller and heavier men, namely, to an increase in weight due to mere passive enlargement of the central system as a result of the enlargement of the bony cavities containing it.

Working along this same general line, Donaldson has been able to obtain a simple formula which expresses for the frog the weight of the entire central nervous system as dependent on the body-weight and length of specimens of different sizes. This work differs

from the foregoing in that it applies to a form below the mammals, deals with the entire central nervous system—brain and cord combined—and expresses the change in the weight of this system in the growing animal.

It should be remembered, however, that the growth of the frog is different from that of the mammal, since at about 5 grams weight the frog presents those proportions of limbs and trunk which are maintained through the rest of its life. The difficulty in carrying out such an investigation lies in the determination of the normal body-weight. Not only are there here present all those difficulties which occur in the case of a mammal, but also variations in body-weight due to the amount of water, a factor which in the frog can undergo wide changes, and in addition, a distinctly marked seasonal variation in the relations between the weight of the central nervous system and that of the remainder of the body, so that for any study of this sort only mid-summer frogs are to be used, or observations on specimens taken at other seasons are to be reduced to the midsummer standard. When due care was taken to obtain correct and comparable body-weights, it was found, in the first place, that the increase in the weight of the central nervous system was nearly similar to the increase in the logarithms of the body-weights of the frogs compared; the series of logarithms did not, however, increase quite so rapidly as did the weight of the central nervous system. Another factor was therefore needed to make the two curves fit. This factor was found in the length of the frog, not applied directly, but with the value of the fourth root. The series of numbers obtained by multiplying in each instance the logarithm of the body-weight by the fourth root of the length, was found to be a nearly constant fraction of the observed weight of the central nervous system.

In the case of the bull frog the denominator of the fraction was 30, and hence multiplying in any instance by this constant would raise the number to the value of the observed weight. The formula for the bull frog is as follows:

$$C.N.S. = (\text{Log. } W \times \sqrt[4]{L})\, C$$

where the *C.N.S.* is the weight of the central nervous system in milligrams; *W* the weight of the frog in grams, and *L* its length in millimeters, and *C* a constant which for the bull frog has the value of 30. A similar formula applies to the leopard frog, save that in this case the constant is 28 instead of 30. In neither species is any difference according to sex to be observed. This indicates that during their

life the increase in the weight of the central nervous system is progressing in a regular manner, and that, too, despite the fact that the changes leading to an increase in weight are probably somewhat different in the large and small frog.

It suggests itself that the factor depending on length may be one which represents the mere passive increase in the system, whereby it adapts itself to the larger cavities in the bigger animals and thus increases in weight without increasing in complexity. If this be true, then we see that those changes depending on increase in complexity steadily diminish as the animal becomes larger. A further analysis of this group of changes must, however, await a better knowledge of the histological modifications which are there taking place. The outcome of the investigation is that any time after it has attained a weight of 5 grams the weight of the central nervous system of either *R. catesbiana* or *R. virescens* can be determined by means of a simple formula, thus showing a regular and orderly progression in those changes which lead to an increase in the weight of this system.

As regards the early growth changes in nerve elements, Hatai has been able to show that in the cerebellar cortex of the fœtal cat, the largest germinal cells present what Flemming calls a heterotypical mitosis. In these cells the number of chromosomes represented by the internodes of the segmental filaments is 16, this being the first determination of this number in the cells of the mammalian central nervous system. These general characteristics are probably the same in the other dividing cells in the central system.

In this connection some interest attaches to those structures in the cytoplasm forming centrosome and attraction sphere. It had been thought by some that since these organs of the cell play so prominent a rôle in cell division, they would probably entirely disappear from the cell when the ability to divide was lost. On searching for the centrosome in the white rat, both young and adult, Hatai found these structures in all classes of cells in the young rat at birth and also in all classes of nerve cells in the central system of the adult except in the cells of the corpus dentatum and the efferent cells in the ventral columns of the spinal cord, where the Nissl granules were so abundant as probably to obscure them.

In general the centrosome in the young rat is more easily distinguished than in the adult but maintains the same size, both in the different classes of cells and at different ages. In most cases the centrosome is composed of two corpuscles, and in the adult rat the attraction sphere and centrosome show changes which are interpreted

as signs of degeneration. It is hardly necessary to add that the cells in the adult which still exhibit the centrosome and sphere, have lost all power of further division.

A good deal of interest attaches to a determination of the time at which this power to divide disappears. On this point some observations of Miss Hamilton have a direct bearing. In her investigations of the nervous system of the white rat at birth and during the first four days after birth, she in the first place finds that cell division both in the brain and spinal cord was in active progress, even in the rat four days old. At first glance this would appear to be opposed to the current statement that in man cell division in the central nervous system comes to an end shortly after the third month of fœtal life. It must be remembered, however, that birth among mammals is an event quite independent of the maturity of the fœtus, and does not serve as a measure of development. The rat is born in a very immature condition, and before any proper comparison can be made between the two animals as to the time of the cessation of cell division in the nervous system, a careful determination must be made of the ages at which they pass through corresponding stages in their development, for in all probability it is the stage of development which is important.

The dividing cells in the older rats are found more and more frequently in the extra-ventricular portions of the section. Miss Hamilton's attention was largely directed to the determination of two sorts of dividing cells, the smaller giving rise to supporting elements, non-nervous in character, while the larger ones developed into neurones. In a number of instances she was able to observe mitotic changes in large cells having several branches, cells which would be classed as multipolar nerve cells. If the changes in the nucleus may be taken to indicate that such a multipolar cell is about to divide, then division in clearly differentiated nerve cells can occur, at least in the central system of the white rat. Opposed to such a conclusion is the accepted teaching that in the developing neurone the nerve fiber process or axone is the first outgrowth to appear. For if this were true it would be hard to understand what would happen to an axone under these circumstances.

It was difficult to attempt any reconciliation between the current teaching of the early development of the axone and those differentiated cells showing signs of division, until evidence was brought forward for the view that in certain parts of the central nervous system, the cerebral cortex for example, it was not the axone but the dendrites which were the first to appear. Bechterew in 1899 was led to

this view from the study of silver preparations of the developing human cortex, and Paton in 1900 reached the same conclusion as the result of his investigation of the histogenesis of the cellular elements in the cortex of the pig. Hatai has been able to corroborate and extend these observations and to show very clearly in the cerebral cortex of the fœtal cat that it is not until after the dendrites are formed and until the neurones are aggregated at a distance from the ventricle in the fourth and fifth cell-layers of the cerebral cortex that the axone appears.

It will be noted that these observations on the late development of the axone apply to the cerebral cortex only, and the question has not been retested since the classic observations of His on developing cells in the spinal cord gave rise to the current view.

Nevertheless, since it is possible that in other parts of the central system the same condition may occur, the presence of differentiated nerve cells, *i. e.*, those with dendrites undergoing division, can be explained without doing violence to any of the established views, for their dendrites may develop before the axone is formed.

As is generally recognized, the growth changes in the central nervous system are the result of two different processes not strictly separated but having a very different value at different periods. In the first period, enlargement of the system is the result of the multiplication of the cell elements by cell division, while in the second period the enlargement is at first mainly, and later, entirely, due to the development of cell elements already formed. Thus in a general way, out of the total number of elements formed by the early cell division, only a fraction undergo immediate development—the completion of which, in the larger mammals, may require years—while for a time, at least, new elements continue to enter upon the changes leading to complete development. Thus while the total number of neurones, immature and mature, is constant, the number of mature neurones steadily increases at the expense of the immature group.

This is the general method according to which the human nervous system is thought to be transformed from its condition at birth to that at maturity. When this series of events is analyzed, and especially when the changes occurring during old age are included, a great number of problems arise, each of which must be settled by a detailed investigation.

In determining the number and size of the spinal ganglion cells and dorsal root fibers in the white rat, at different ages, Hatai has dealt with one of the problems in question. The investigation takes de-

parture from two fundamental points. First, that at and after the age (about 8–10 days) of the youngest rat examined, there is no internal evidence that any cell division takes place in the cells of the spinal ganglion, and second, that all the medullated fibers in the dorsal nerve roots of the spinal cord are outgrowths of cell bodies located in the spinal ganglia. The evidence for fibers in the dorsal nerve roots having a different origin is, in mammals, at present too slight to impair the validity of the second point. If these points are accepted, then from the age when the rat weighs ten grams on to maturity, the number of cell bodies should remain constant. This can be determined only by comparing corresponding spinal ganglia in different rats of different ages. In this case we should hardly expect the number of cells to be exactly constant, since individual variations must occur. A study of the number of ganglion cells in four rats, the cells in three corresponding ganglia being counted in the case of each rat, shows that the number of cells in a given spinal ganglion does not increase with age, but remains constant. If the general view previously stated be correct, namely, that the neurones of this group mature in series, so that as the animal becomes older a larger and larger number of mature elements is to be found, then we should for one thing expect the number of medullated fibers in the dorsal roots to increase. Such is found to be the case. Taking all the fibers in the dorsal nerve roots, without distinguishing those which are entirely mature from those which are still immature, Hatai finds that in a rat of 167 grams body-weight there is something more than twice the number which appears in the nerves of a rat of 10 grams body-weight. If, however, attention is directed to the fibers which are entirely mature, the rat of 167 grams has from 4 to 5 times (according to the nerve) the number found in the young rat of 10 grams. Here, for the first time in the case of a mammal, Hatai has been able to follow the slow constructional changes by which the afferent system is put into connection with the spinal cord. This is seen to be accomplished by the prolonged post-natal development of the neurones, all of which are represented in the ganglia of the youngest specimen in the series. A host of questions at once arises. Do we know that we have reached the limit of this addition of new fibers? The question can be answered only by the study of older and larger rats than that which forms the upper limit of this series. Are all the cells of the ganglia represented in the dorsal nerve root by medullated fibers? In reply to this question, Hatai can show that since in a given ganglion the number of cells is constant, while the number of fibers in the dorsal root in-

creases, the ratio of fibers to cells must be a diminishing one, but in no case does he find less than 2.7 cells for each fiber that appears in the root. This agrees with results of other investigators who have always found more cells in the ganglion than there were fibers in the dorsal root. How far this group of neurones, which does not contribute to the dorsal root fibers, does contribute to the internal complexity of the ganglion, and how far the extra cells are both physiologically and morphologically immature, further investigation must decide.

No one can look at the growth changes here taking place without feeling that variations in the amount of exercise would modify the results, and also wondering to what extent these changes in the growing nervous system of the rat are exhibited by the growing nervous system of man.

It seems most probable that such changes occur in man, but further investigation alone can show at what period the afferent pathways represented by the spinal nerve roots become numerically complete, or the rate at which that completeness is attained. It is by studies in this field, and, so far as possible, on human material that the information can be obtained to show how far the nervous system is growing during the period of formal training, and therefore what possibilities there may be of modifying its later growth by exercise and stimulation.

From quite another side Cunningham, in his presidential address given before the Anthropological section of the British Association for the Advancement of Science at the meeting of 1901, discusses some growth changes which affect the human encephalon as a whole. He there points out that in considering the encephalon and its relations to the cranium we must regard the encephalon as the important factor, and that by its growth the form of the bony envelope has been largely determined, thus the lofty cranial vault of the human skull is a consequence of the great development of the cerebral hemispheres in man. If the cranium in its various modifications can be looked on as the outward expression of the contained encephalon, a newer craniology may, with this idea as a guide, describe more accurately than heretofore the variations in the development of the encephalon in the different races of mankind.

In this connection Cunningham takes up certain growth changes in the cerebral hemispheres which he believes to be especially characteristic of man, and which 'unquestionably have had some influence in determining head forms.'

The primate cerebrum, in contrast to that of the lower mammals,

is distinguished by the possession of a distinct occipital lobe and by a convolutionary design which in all but a few fundamental features is different from that of any other order of mammals. Up to the time when the occipital lobe is formed on the cerebral hemispheres—that is, the time when the cerebrum changes from the quadrupedal to the primate type, the cranial envelope is closely applied to the surface of the cerebrum. At this period it would appear that there existed an antagonism between the cerebrum and the enclosing walls, although Cunningham still considers the evidence which has led to this view as insufficient. With the development of the occipital lobe, however, these relations undergo a complete change. The cranium expands more rapidly than the cerebral mass, a considerable space filled with spongy subarachnoid tissue is formed between the two and into this mass the first convolutions of the cerebral surface are pushed out. This opportunity for free growth, however, becomes less and less as the end of the pre-natal period is approached, so that at the time of birth the gyri which have been formed are closely compacted and the cranium is so moulded over the surface of these gyri that the outline of the summits of the gyri is impressed on the inner surface of the cranial wall. Pursuing further the peculiarities of the human cerebral hemispheres, Cunningham points out that the other primates also exhibit a well-developed occipital lobe. Indeed, it appears that in man the region of the occipital has suffered a comparative restriction through the encroachment of the parietal region upon it. It is to this latter region that Cunningham especially calls attention.

The recent work of Flechsig on his association-centers, the whole literature of aphasia, as well as the studies of Rüdinger on the brains of eminent persons, serve to indicate the great importance of this portion of the cerebral surface. Nevertheless, Cunningham does not find any warrant for Rüdinger's sweeping statement that the higher the mental endowment the greater is the relative extent of the superior portion of the parietal lobe. On the contrary, he finds that it is the lower part of the lobe which in man, both in the earlier development and the after-growth, shows the greater relative increase.

He doubts whether the evidence is sufficient to support the views of certain authorities that an ample development of this region is to be found in the brains of men of unusual ability, but at the same time the peculiarly generous development of it in the human cerebrum makes it a region worthy of careful study. In the further examination of the inferior parietal lobe, it is pointed out how in connection with the frontal lobe it forms the superior operculum of the insula, and how in

this way it grows downwards to meet the inferior operculum formed by the temporal lobe and so to give rise to the Sylvian fissure. The interesting point here is the angle formed by the Sylvian fissure with a horizontal plane; this angle in the young human brain, as in the primate brain generally, is large, but in the human brain alone becomes less and less as the brain matures and thus the Sylvian fissure approaches the horizontal plane. This change in direction towards the horizontal is referred to the more rapid growth of the inferior parietal lobe in its posterior or occipital portion, this part of the operculum being more energetic in its growth than that formed by the temporal lobe. As a result, Cunningham states as his own observation the very interesting fact that in the left cerebral hemisphere the Sylvian fissure, as marked by the lower boundary of the parietal lobe, is more depressed than in the right hemisphere, thus showing an overgrowth on the left side. This overgrowth, he argues, is associated with the functional differentiation of the left hemisphere, the greater physiological importance of which, especially in connection with the faculty of speech, he considers very important. This leads to a discussion of language, and the peculiar importance of the development of it in man, with which topic the address closes.

Returning now to the statements concerning the better development of the inferior parietal lobe in the left hemisphere of man, we may be permitted to raise the general question of differences between the right and left hemisphere. As Cunningham himself states, it can be shown that the superiority of the left hemisphere depends neither on greater weight, greater convolutional complexity, better blood supply or better development (*i. e.*, higher specific gravity) of the cerebral cortex.

This being true, then the greater growth of the inferior parietal lobe must be compensated for by a smaller development of some other part of the hemisphere. Moreover, according to Eberstaller (1890) the principal external portion of the Sylvian fissure is longer on the left side than on the right, and longer in the brains of women than of men. The greater length of the fissure would certainly suggest a less complete development of the opercular masses, and in so far point to a smaller rather than a greater cortical extension on the left side.

Moreover, while all that Cunningham says concerning the great significance of the cerebral mechanism for speech and for the control of the finer forms of expression is most acceptable, yet the neurones immediately concerned in the control of the muscles from the cortex are predominantly in the frontal lobe and not in the parietal, so that

the enlargement of the parietal region is at best an associated change, and since the weight of the left hemisphere does not surpass that of the right, it is also a change which must be compensated by the smaller growth of some other point.

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PSYCHOPATHOLOGY.

Psychopathological Researches: Studies in Mental Dissociation. BORIS SIDIS. New York, G. E. Stechert. 1902. Large 8vo. Pp. 329 and ten plates.

In the preface to this handsomely printed volume we are informed that the publication has been made possible by the Trustees of the New York Infirmary for Women and Children (and especially by Dr. Alexander Lambert). The Psychopathic Hospital and Laboratory established by them continues the work of the former Pathological Institute of the New York State Hospitals. Dr. Sidis is the director of the Psychopathic Laboratory and in presenting this first volume of studies, announces another work to be entitled 'Principles of Psychology and Psychopathology.' While this future volume will naturally be of more direct interest to psychologists, the present series of case-records presents many starting points for suggestive psychological thought. The central doctrine to which the several cases contribute is that of dissociation; and as a result of these experimental inquiries that conception acquires at once a more definite, a more comprehensive, and a more important significance. Unquestionably the psychology of the subconscious forms one of the notable problems of contemporary inquiry; and its illumination from the side of the abnormal has, up to the present, been the most distinctive aspect of the inquiry. Along with an appreciable volume of critical investigation and judicious generalization has been put forth a far greater mass of half-baked theories and conclusions, in which all sorts of discoveries of coexisting personalities, subliminal selfs, splintered egos, strata of the unconscious, run riot; while hypnotism is yielded as a potent weapon that opens out secrets of mind as easily as a blow with a hammer lets the milk flow out of a cocoanut. It is fortunate that Dr. Sidis has determined to take up this problem from the point of view of the psychological alienist; to apply to it the methods of inquiry suggested by psychological analysis, and to interpret the phenomena presented as extreme or aberrant forms of mental interrelations the analogues of which are to be found in normal mental functioning.

Dr. Sidis's remarks upon the suggestiveness of the simpler forms of phenomena are particularly apt in the field of psychology. It appears, moreover, that this method of research reveals modes of successful treatment, where the ordinary methods have failed.

The cases described belong to the vast area of functional psychoses; they include cases of hysteria, of amnesia resulting from an overdose of alcohol, of delusional states with variable emotional concomitants, of psychic epilepsy, or simulants of epilepsy, of motor disturbances, pseudo-paralysis, etc. In all an existing, more or less transitory (and sometimes recurrent) state of consciousness differs from and is seemingly unrelated to the normal, usual consciousness; the bridge between the two is in typical cases invisible, the transition abrupt, the habit of thought and conduct seriously altered. What Dr. Sidis and his associates have attempted in the cases described, is to determine how far these abnormalities find their origin in subconscious experiences; when such are established, the subconscious storehouse is 'tapped' by aid of hypnosis, or of ingenious variations of hypnoidal conditions. Thereupon, first, by means of proper suggestion the genesis of the psychopathological state, which the patient is unable to report upon in his present condition, is gradually brought to light; secondly, these dissociated experiences are reconnected with the normal consciousness (synthesis of the dissociated states); thirdly, the abnormal factors in the composite are by the same means suggested away, and recovery takes place. This bare description seems both vague and theoretical; it needs to be applied to the special cases to ensure a realization of its significance. For this the reader must be referred to the original, as the cases can hardly be reproduced in outline; the thread of detail and the sequence of stages are needed to produce an intelligible and convincing narative.

The importance of this volume will depend upon the possible extension and corroboration of the methods and results therein presented. If, indeed, it can be established that in a large proportion of mental difficulties (the true psychopathies), the source of the aberration lies in the fact that the subconscious background slips away from the normal relation to the foreground, until by its emotional persistence or otherwise it usurps the place of the foreground; and if, further, restoration to normal conditions be possible through an appeal to the deranged mental products by hypnosis, then the value of the analytic psychological method will receive a most notable confirmation, and the term 'psychotherapeutics' acquire a more rational meaning and a valuable extension. How far such will prove to be the case the

future will decide; and Dr. Sidis's attitude toward his data will probably be set forth in the promised volume.

The psychological reader of this volume will find some presentations that do not command his full acquiescence; he will find details that seem to him superfluous or meaningless; he may have doubts as to the precise nature of the 'hypnoidal' states described and their possible production in normal individuals. He cannot fail, however, amid such diversity of opinion as he may discover, to find an unusual collection of psychological material, and of suggestive illustrations of established and tentative psychological principles. A volume having these characteristics is worthy of careful scrutiny.

JOSEPH JASTROW.

UNIVERSITY OF WISCONSIN.

La perception visuelle de l'espace. B. BOURDON. Bibliothèque de Pédagogie et de Psychologie. Paris, Schleicher frères. Pp. 460.

The first seventy pages of the book are devoted to a description of the structure and functions of the eye. Here, as throughout the book, the author has brought together in condensed form, material from all the more elaborate treatises and from the scattered periodical literature bearing on his subject. To a review of the borrowed material he has added many carefully formulated criticisms and many original experimental data.

The most important original contribution in the first section of the book is the conclusion that the eyelids are sources of tactual sensations which play an important part in the visual perception of position. The lids are very sensitive on their inner surfaces according to the observations reported, and they are very active during movements of the eyes. In this connection it may be said that of all the tactual sensations involved in visual perception, those from the eyelids seem to be recognized by the author as the most important. Muscle sensations are everywhere treated as relatively unimportant, contributing little except, perhaps, in the case of recognition of depth, where convergence and accommodation are both recognized as contributing, together with other tactual factors, muscle sensations of some importance. It is retinal stimulation which the author repeatedly emphasizes as the main source of the sensations involved in visual recognition of space. When tactual sensations are recognized at all, they are chiefly the sensations from the lids.

After the first general description of the eye and its functions there

are chapters dealing with plane figures, with perception of movements and of depth, and with illusions. The separation of plane figures and geometrical illusions is a very serious defect in the book. It is evidently due to the author's great interest in such problems as the extent of the minimum visibile, the accuracy of the recognition of vertical and horizontal directions, and the degree of ability to arrange points in different parts of the field of vision in straight lines. These problems are the ones on which the author reports original observations. The observations reported are, for the most part, the author's personal observations. In a few cases one or two other subjects took part in the investigations, but in no case are the results sufficiently numerous or unique in character to modify the commonly accepted conclusions on all these matters. The author's lack of special interest in geometrical illusions, on the other hand, appears in the fact that he does not attempt any original contributions to this part of his work. He is content to be a mere reviewer in this field. The result is that the theory of the visual perception of plane figures is not greatly advanced by the book. So far as the general position of the author is definitely formulated, it may be said to favor the doctrine that space perception depends mainly on retinal sensations and only very secondarily and indirectly on tactual sensations.

In the treatment of the perception of movements and the perception of depth, the author again appears as an original contributor to the data. Convergence is regarded as a factor in both monocular and binocular perception of depth. With reference to the much debated subject of the relation of accommodation to monocular perception of depth, the author sides with Wundt. Though the importance of movement is thus recognized, greater emphasis is laid on retinal factors. The sensations from corresponding points in the two eyes are found in a series of experimental observations to be clearly different from each other, and sensations from disparate points do not fuse when the eyes are carefully fixated.

In the perception of movements of objects, tactual factors again receive some recognition, though the part played by those tactual factors is clearly regarded as subordinate to the part played by retinal factors. The relative significance of the two kinds of sensations is typically illustrated in those cases of illusion in which the real movement is in the eye and not in the object, but is, through a failure to recognize the eye movement, interpreted as belonging to the object. The dark-room experiment of trying to fixate a luminous point was repeated by the author with the usual result of involuntary eye move-

ments and interpretation of the movements as belonging to the objects. The directions of such movements were carefully recorded and traced to the involuntary and unperceived action of the eye.

The last part of the book reports facts in regard to the development of visual perceptions in children and in congenitally blind persons who have had their vision given them through operation; also the facts in regard to the recognition of the sizes of the sun and moon, and the facts of association between hand and arm movements and visual ideas. All the discussions here presented are summaries of the work of other investigators, except in the case of the discussion of the apparent flatness of the sky which is treated in the light of personal observations as well as in the light of what others have reported on the subject.

As a general text-book this number of the Bibliothèque has succeeded admirably in carrying out the purpose of the series to which it belongs. Much material has been carefully and critically worked over. It is evident that French and German sources have been more freely used than American or English sources. This will make it none the less useful to American students who may wish to complete their references on the subjects discussed. We are well enough supplied with English references in our own English text-books; the French writers particularly will be easily available through this work. The author's own experiments also present, as indicated above, valuable contributions to a number of the topics.

CHARLES H. JUDD.

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APPARATUS.

The Psychergograph: A method of measuring mental work. C. E. SEASHORE. Studies in Psychology, Iowa University, Vol. III., pp. 1–18.

A Voice Tonoscope. Ibid. Pp. 18–29.

These two articles may be reviewed together and in their order:

The 'psychergograph' is an instrument containing a circular disk 38 cm. in diameter, the circumference of which is divided into one hundred equal spaces, and upon each of these spaces is pasted one of four colors. These colors are arbitrarily arranged into a series, and as the disk is rotated one color after another is exposed through a signal slot in a screen covering the disk. Immediately behind this signal window are four keys containing each one of the four colors in the series on the disk. Every time one of these keys is pressed down the disk passes forward one one-hundredth of a revolution, thus exposing

the color on the next space of the disk. The idea is to press down the keys as their respective colors appear in the signal window. These keys are electrically connected, both with the disk, which passes one notch every time a contact is made on any key, thus bringing a different space of the disk under the window, and with four markers, each key with its respective marker. These markers make continuous tracings on a tape passing under them at a uniform rate, and a time record is also made on the tape. All the contacts of each key — errors, time relations, and fumblings — are recorded and can be determined at leisure.

This seems a good and handy instrument for the psychological laboratory and some valuable researches may be carried on by means of it. It can be used to make practice experiments, experiments on continuous reaction time, on fatigue and its effect, on rate and accuracy of discrimination, etc.

The advantage of the 'psychergograph' over the rate of reading, for example, is that it gives a record of the variability, but this brings no particular intelligence, unless treated *en grosse* to get results and standard. Dr. Gilbert ('On School Children,' *Yale Studies*, Vols. I. and II.) found only slight correlation between mental tests and reaction time. Association time goes better. Idiots have twice as long association reaction time as school children ('Feeble Minded People,' *Ped. Sem.*, Vol. III., p. 246, G. E. Johnson). Dr. Wissler found that reaction time is a very poor measure of mental efficiency since it does not correlate at all well with any of the other mental tests of Columbia freshmen ('Correlation of Physical and Mental Tests,' PSYCHOL. REV., Mon. Sup., Vol. III.). Rate of reading seems one of the most satisfactory tests so far given, and it is not unlikely that tests that might be given on the 'psychergograph' would be as unsatisfactory as any in finding a norm of mental work. Tests of mental work ought, as far as possible, to eliminate muscular work.

The 'voice tonoscope' referred to above is made up of a stroboscopic screen of heavy white paper tightly fitted around a metal drum, mounted on ball-bearings, 50 cm. in radius and 50 cm. wide. On this screen and equidistant are placed 71 rows of dots 3 mm. in diameter, so that when the drum is revolved all these rows will form parallel lines 3 mm. wide. These rows of dots are divided into two series, the first of which contains 36 rows and the second 35. The first row of Series One has 73 dots, equidistant, in its circumference, and each succeeding row has one more dot. The rows of Series Two alternate with Series One, beginning with a number of dots where the

first series ended and each successive row increased by one dot, thus ranging the number of dots in the rows of the two series respectively from 73 to 145 in a revolution of the drum, and forming dot frequencies when the drum is revolved at one revolution per second, which correspond to the vibration frequencies of the human voice. To show the dot frequency of any row in a revolution a scale showing the number in that row is placed horizontally against each side of the drum.

To revolve the drum at the rate of one revolution per second a vacuum tube is placed above the scale on one side of the drum. This tube is electrically connected with a 100 v. d. fork. Then the drum is started and speed increased until the dots in the row having 100 dots in its circumference seem to stand still. This becomes the standard rate of speed. On the opposite scale is placed a manometric capsule, connected with gas and speaking tubes. The observer holds the speaking tube to his mouth and sings the tone that is to be determined. The gas flame rises and recedes once for every vibration of the vocal organs, and when the screen is moving at the standard rate the row of dots will seem to stand still on the screen whose dots correspond to the frequency of the vibrations of the tone and the pitch is indicated on the scale by the number over the line standing still. There is also a telephone connection between the standard, *i. e.*, 100 v. d. electric fork, and the observer can at any time get the standard tone through the receiver. The experiments are carried on in a darkened room.

This is an instrument very ingeniously devised and is bound to be as useful as the Hipp chronoscope. Experiments for which it can be used and which have been pointed out by its inventor are: (1) ability to sound a tone, (2) variability in sustained tones, (3) singing tones at certain pitch intervals, (4) ability to run scales and to sing melody, (5) speaking in a uniform pitch, (6) the least producible difference in pitch.

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CHILD PSYCHOLOGY.

La logique chez l'enfant et sa culture. Étude de psychologie appliquée. FRÉDÉRIC QUEYRAT, Professeur de philosophie au Collège de Mauriac. Paris, Félix Alcan (Bibliothèque de philosophie contemporaine). 1902. Pp. 158.

This book belongs to the author's series of monographs on applied psychology, and is closely connected with his 'L'imagination et ses variétés chez l'enfant,' and his 'L'abstraction et son rôle dans l'éduca-

tion intellectuelle.' While the first of these treated of the rise of images, and the second of the formation of general notions by association of ideas and other means, the present volume goes on to investigate the rise and development of the power of relating notions and judgments in what we call reasoning proper. The child's intellectual life is divided into three periods, according as *sense, spontaneous thinking* or *reflective thinking* plays the chief rôle. The second of these periods begins about the third year; the third from four to seven years later. The logic of the earliest childhood is that of loose analogies, personifications and anthropomorphisms, and is subject to numerous errors and sophisms. Out of this the young reasoner slowly emerges, as the principles of identity, causality, and finality assert themselves, dominate his thinking and correct the vagaries of his earlier analogical reasoning, which was controlled almost entirely by chance associations of images of sense. Chapter three gives a very interesting account of the main sources of logical fallacy, and might be accepted as a fairly good statement of this part of the subject, as applied not only to the child, but to the adult as well. This is followed by a description of the various logical types, with historical illustrations; and the closing chapter of the book is devoted to a discussion of the chief subjects of study, with respect to their relative value as means to the training of the reasoning powers. While one can hardly say that much new material is presented in this book, it is nevertheless well worth reading on account of the skillful manner in which familiar material is arranged and classified, and pedagogical deductions drawn therefrom.

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FEELING AND EMOTION.

Les émotions. G. SERGI. Paris, Octave Doin. 1901. Pp. 460.

This is a French translation of the author's 'Dolore e piacere' with an added chapter dealing with recent criticism of the theory — the James-Lange, or, as the author prefers to call it, 'peripheral' theory of emotion — which it is the principal aim of the work to expound and defend. As the Italian original was reviewed at length in these pages (Vol. II., p. 601), at the time of its appearance, it will suffice here to remind the reader, with the briefest possible comment, of the principal features in Sergi's holding of the doctrine, and to call attention to what is new in his reply to objections. It is to be noted, in the first place, that while James rested his theory mainly on the evidence of intro-

spection — we always experience organic perturbation whenever we are emotionally moved, and we can't imagine ourselves emotionally moved if we think all organic sensations absent — Sergi relies largely on more or less philosophical assumptions in the interpretation of biological and physiological facts. His view at bottom is that the whole mental life is a transformation of primitive organic irritability and that the latter in its turn is a transformation of physical energy. Irritability, he teaches, conjoined with consciousness becomes in the nervous system sensibility, with sensation, involving cerebral centers, as its function, consciousness being not a distinct phenomenon in itself, but a property, or manifestation, of a phenomenon taking place, or rather that has already taken place, in the nervous centers. Sensation and consciousness thus conceived, the primitive phenomena included in sensation are held to develop in two directions: (1) Perception and the intellectual phenomena, (2) sentiment, or feeling (primarily pleasure and pain), and the emotional phenomena.

With these most general assumptions, Sergi proceeds to construct his theory. The first step is to connect pain and pleasure with the vital functions. Pain is held to be a form of irritability due in all cases, even those of inaction, to excessive and, therefore, harmful stimulation, pleasure a form of irritability due, negatively, to the return to normal organic conditions, positively, to novel excitements, the more precise nature of which is not here further defined. The indications thus afforded by the external conditions of pleasure and pain of their relation to organic welfare, more obvious in the case of pain than in that of pleasure, which is biologically valuable chiefly as a means of avoiding pain, are definitely established, in Sergi's opinion, by their relation to the vital processes — the inner movements of heart and lungs — controlled by the nervous centers in the region of the fourth ventricle. This relation is regarded as primary. That the function of the brain in bringing these movements to consciousness is only secondary is inferred from the fact that they are unaffected by ablation of the hemispheres. Sergi makes at this point the important assumption, which he appears to consider the facts mentioned to prove, that this vital center in the medulla is, or contains, at the same time the center of pleasure and pain. It seems to be suggested, though the thought is too vaguely expressed for one to be certain, that the feelings of pleasure and pain are either the consciousness of the cardiac and respiratory movements, or of the sensations to which they give rise, of the changes in the centers in which they originate.

Emotion, now, being regarded as a further development of the

pleasure-pain feeling, the theory of emotion is given in the definition of the special conditions and other features characteristic of the more developed state. Three elements especially appear in Sergi's descriptions as these additional factors: (1) the perception or idea which serves as the stimulus, (2) the associated habits or dispositions — 'psychic organisms,' they are called — which give to the action its instinctive character, and (3) the diffuseness of the organic discharge, which includes in its effects secretory and other changes as well as affections of the heart and lungs. Central in the whole process, for the author, is the affection of the vital center in the medulla, the importance of which for the functions of life is emphasized by diagrams and by a special chapter of description. Emotions, then, are regarded as having the same origin, as well as the same basis, as pleasure and pain. They are primarily for defense. They also have the same exaltative or depressive character, a principle which our author uses for their classification. Painful emotions have their genesis in change of vital function consisting in a diminution of activity (though pain, we remember, is always due to excess of stimulus), agreeable emotions in real or apparent augmentation of activity. The consciousness of the emotional process is, of course, secondary, just as in the case of pleasure and pain, but just as in that case also, it is not clear at this point whether it is to be thought of as consciousness of the process in the medulla or of the organic movements or sensations as they occur in the other parts of the body.

Such in its main outlines is the theory. In the chapters following those which contain the above foundation principles Sergi seeks confirmation of his view in special analyses. Among other things he attempts, not unsuccessfully, to bring the æsthetic, moral and religious sentiments, which James had set apart as the 'subtler' emotions, under the general theory. And in the final chapter, the new chapter of the present edition, in approving many of the criticisms made against James, he claims superiority for his own view in its manner of conceiving the theory, in the determination of a common emotional center, in the use made of the hypothesis of psychic organisms and in the inclusion of the æsthetic, religious and moral emotions, treated as merely transformations of the emotions of common life and by no means always the subtler.

The advance beyond James's earlier statement is apparent. It consists essentially in the endeavor to relate the emotions to the principle of biological utility. The emotional life is so fundamental, so instinctive in its manifestations and so obviously connected with the

organic life of nutrition that its primary significance relative to conservation can scarcely be doubted. But while the author is to be commended for making this conception central, it is to be feared that he has left much to be desired in the working of it out. To begin with, if emotion is to be conceived as feeling with reference to an instinctive organic reaction relative to defence, the first requirement for a theory of the emotions would seem to be to define their place with regard to this self-preserving or, as the case may be, group-preserving attitude. There is little or nothing of this, in the sense here meant, in Sergi's work. There is, indeed, much said about the derivation of certain movements, especially the æsthetically non-useful, pleasure-giving movements of the dance, from movements having originally symbolically useful social significance, and there are here and there allusions to the abbreviations of originally useful movements in emotional expressions. But there is no attempt to synthetically relate stimulus and reaction, on the one hand, attitude, object and feeling, on the other, or to explain why, in view of their teleological character, emotions as we experience them are so disturbing. The author's tendency, on the contrary—it appears, in fact, to be a part of his express theory—is to assimilate emotions, so far as their teleological reference is concerned, to feelings of pleasure and pain, and to refer the rest to indiscriminate and diffused discharge of nervous energy. As to his doctrine of a special emotional center, identical with the center of pleasure and pain and the center of origin of the vital processes in the fourth ventricle, a doctrine on which he lays much stress, it is difficult to see what more such a center could effect, assuming its existence, than to serve as a 'funnel of discharge' for the cerebrally excited motor currents, which, according to Sergi, James, rejecting the idea of an emotional center, erroneously regards as reflex. There is clearly nothing in James's theory to preclude the idea of such a special 'funnel of discharge' in inferior centers. The question is purely physiological. But Sergi finds in the doctrine of a medullary center of emotion psychological significance. And he appears to think that the center in question is a true center of the life of feeling, a life which the hemispheres only bring to consciousness, notwithstanding the very obvious consideration that pain, pleasure and emotion are terms entirely devoid of meaning except as they denote just those states of consciousness themselves. An emotional center, therefore, in the proper sense, would have to be sought, on the author's own showing, in the hemispheres, where, it is needless to say, there is not the slightest evidence of its existence. And so, in the end, we find Sergi returning to James's

contention that the emotions are simply sensations of the viscera, *i. e.*, effects of the return wave of the excitement instinctively discharged through the organism from the brain. Thus, in reply to Stumpf, who criticised the general theory for its failure to supply a distinction between emotion and organic sensations not emotions, *e. g.*, a stomach-ache, he says, the distinction lies in the difference of the cause, also in the fact that in localized sensations producing pain consciousness is chiefly occupied with those localized sensations and not with the visceral sensations they give rise to, whereas in emotion it is more occupied with the visceral sensations, non-localized and diffused. The explanation suffers from the often pointed out defect in the statement of the theory, namely, the failure to connect the different elements in the process of emotions, since, apart from their relations in the emotional attitude, organic sensations, though visceral, are not emotional at all. But it at least serves to show the subordinate rôle of the so-called emotional center as a motor mechanism. This further appears in the reply to Ribot's demand that the psychophysical emotional process be conceived in a unitary way, without reference to the distinctions of cause and effect. Sergi contends that changes in circulation, respiration, etc., excite organic sensations, without being themselves organic sensations, just as light, etc., stimulate the external organs of sense. The organic sensations which constitute the feeling consciousness are thus at a second remove from the action of the vital center which excites the visceral changes and, of course, still further removed from the originally exciting perception or idea.

Besides James, Ribot and Stumpf, Sergi especially criticises, in the last chapter, Binet and Courtier, whose experiments on the relation of emotion to vaso-constriction, and Binet and Vaschide, whose experiments on its relation to blood-pressure showed, in the opinion of these writers, that no such relation obtained as the James theory required. He makes it clear that the facts are capable of being interpreted as either negative or as tending to confirm the theory. The rest of the chapter seeks to establish the theory by fresh evidence. First Mosso and Tanzi's observations, showing increase of temperature in the brain in connection with emotion, but no increase in temperature accompanying the increase in blood-supply and modifications of circulation in intellectual work, are cited as demonstrating the peripheral or sensualistic theory and giving to the intellectualistic theory its *coup de grâce*. They are also held to make for the author's view that psychic phenomena are a transformation of energy, like heat (p. 450). The facts are certainly curious, but hardly a warrant for such

a wide-reaching interpretation. Then the experiments of a number of investigators (Dogiel, Tarchanoff, Patrizi, etc.) are adduced to show the sensational organic character of the effects of music. Finally, the theory is confirmed by introspection, the author having noted, he tells us, on several occasions the presence of the idea in its completeness before the emergence of the emotion — an observation which one may modestly beg leave to doubt, if by the 'idea' be meant the consciousness of the object relatively to which the emotion is felt.

In spite of grave defects, among which is a certain specious simplicity masking vagueness of conception, as in the conception of a vital or pleasure-pain-emotional center, the conception of the relation of consciousness to sensibility, and the conception of psychic phenomena as a mode of energy, the book contains much that is valuable and suggestive. It contains probably the most complete exposition of the doctrine advocated in its various aspects, and the student interested in the subject is to be congratulated on now having it in a language more available to most than the original. H. N. GARDINER.

SMITH COLLEGE.

ÆSTHETICS.

Etudes esthétiques. GEORGES LECHALAS. Bibliothèque de philosophie contemporaine. Paris, Félix Alcan. 1902.

Under this title M. Lechalas has collected a series of pleasantly-written essays on topics of interest to both the critic and the psychologist. Beginning with two introductory chapters on the nature of beauty and art, he proceeds to discuss the relation of art to nature and to mathematics, the rôle of suggestion in art, the affinities of the various arts, art and curiosity, and art and morality. The treatment throughout suggests the critic who has read rather widely in modern experimental psychology and has used its results to illustrate and enforce principles adopted on grounds of personal taste, so that the essays, while interesting, are in no sense contributions to the science of æsthetics. They belong to the literature of criticism rather than to that of psychology, and draw their inspiration from Sully-Prudhomme and Fromentin rather than from Fechner or from Wundt.

The value of the author's theoretical basis may appear from the fact that having reduced beauty to the manifestation of being or perfection, and realizing the traditional difficulty as to the reality of the ugly or non-being, especially of the morally ugly, he takes refuge in a citation from Malebranche in which evil is given a *quasi* reality by casting it upon the free will of the individual. The essay on nature

and art is a summary of the difficulties which beset the artist in any attempt to reproduce the exact impressions from the object, as these difficulties have been brought to notice in Weber's law and the principle of relativity. Upon this practical impossibility of an exact realism is based a plea for a less mechanical interpretation of nature. In discussing the place of suggestion in art, the author finds it necessary to distinguish between the natural appeal to the attention which every work of art must make and that abnormal concentration of attention which we find in the hypnotic state. Reality must be suggested, but not so strongly as to destroy the distinction between it and the artistic representation—the beholder must not be hypnotized into belief in its reality. This principle of æsthetic *Schein* is of course good, as well as ancient, but when it is applied in criticism of the Bayreuth performances (which the author admits that he has never seen) it fails to convince. The concentration of attention upon the lighted stage in the dark and silent house is certainly far from destroying either the æsthetic illusion or the contagious influence of the audience.

The concluding papers on the relation of art to curiosity and to morality are purely non-psychological and also somewhat misleading in title. The former is a discussion of the place of subject and local color in art, the latter a rather loose treatment of some of the moral evils which are the possible results of art and its study.

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ETHICS.

Constitution de l'éthique: quatrième essai sur la morale considérée comme sociologie élémentaire. E. DE ROBERTY. Paris, Felix Alcan. 1900. Pp. 223.

M. de Roberty begins this the fourth essay in his series of ethical writings with a brief confession of his philosophic faith. His general position, often called modified positivism, sometimes attacked as a defection from positivism, he himself calls hyperpositivism—a name first applied to it in a depreciatory sense, but which he adopts as the symbol of his divergence from Comte. The positivist school errs in recognizing only one series of the products of intelligence, the scientific series; it ignores the 'grande' or 'psychosocial' series which includes philosophy, art, and industry, as well as science. In place of Comte's law of the three states M. de Roberty substitutes the 'law of correlation between the abstract sciences and philosophy.' Positivism inverts the

relation of these two terms of the mental series, the complete order of which should read: science, philosophy, art, industry. Philosophy and religion are determined by science, the æsthetic sentiments are determined by the prevailing religious and philosophical beliefs, and finally our practical activity reflects our sentiments and ideas: so that each term of the series depends upon all that precede it. Misconception of the mutual relation subsisting between the different members of the psychosocial series caused Comte to fail in the attempt to 'constitute' sociology as an abstract science. His first error was in separating morals from the totality of sociological studies, whereas, according to Roberty, ethics and sociology are in reality identical.

Sociology (or ethics) is not to be founded upon biology, nor should it be confounded with psychology (another of Comte's errors). It is a mistake to make either individual or collective psychology the basis of sociology; though it is less pernicious to make individual psychology the middle term, giving the primacy to collective psychology and considering the latter as the source of both individual psychology and of sociology, than it is to make collective psychology the middle term with individual psychology below and sociology above. Nor is sociology identical with *Völkerpsychologie;* the former underlies the latter. It is important to distinguish between the *fait social* and the *fait mental.* The latter is the necessary consequence, the inevitable product (manifesting itself in individual minds) of the contact, the reciprocal action, of living organisms already endowed with psychophysical faculties (*fait social*). Social phenomena precede, originate and sustain mental phenomena. But they are not identical with vital phenomena, nor are they to be found in some sphere vaguely said to lie between biology and psychology. The connecting link between biology and psychology is found in the phenomena of sociality, or altruism, or (if one prefers) of the moral sense. The 'biosocial' theory recognizes in sociality the true productive cause of the socially qualified individual, the person of rights and duties. The theory of 'collective psychism' (*psychisme collectif*) sees in sociality the *quid proprium* of sociology.

The three fundamental conceptions in the author's view of the nature of ethics are thus: (1) His view of the relation between the various factors of superorganic evolution, (2) his 'biosocial' theory, (3) the 'collective psychism' hypothesis. The combination of these leading ideas results in the doctrine that psychology is a concrete science studying the complex phenomena of mind—which are due to the concurrent action of the laws of life and of sociological laws; while soci-

ology is an abstract science of the vast world of superorganic facts, a science whose essential phenomena are identical with those of ethics. More briefly, sociality and morality are identical; so that, instead of blotting the word sociology out of the dictionary, as would be necessary if the collectivist psychology were right in identifying social phenomena with mental phenomena (p. 119), it would seem that the word ethics can now be blotted out.

Having dealt, in Chapters IV. and V., with the relation between morals and the other sciences contained in the first term of the psychosocial series, the author proceeds in the last two chapters to deal with the relation between morals and philosophy (including religion). Religion and metaphysics are here treated in the familiar patronizing manner of the positivists, who see in them once useful phases of thought now happily fast becoming obsolete. Until ethics has once and forever cut loose from metaphysics it will remain a normative science, encumbered by duties and imperatives, and saying 'One ought,' while the sciences arrived at maturity say simply, 'This is.' As to theology: Positivism failed because, among other reasons, it did not really do away with God. *Dépasser Dieu* is the real end of science arrived at the age of reason.

To indicate the general tenor of M. de Roberty's ethical views is not difficult; but to disentangle the constructive element from the superabundance of critical digressions and *obiter dicta*, and to read through the repetitions which are perhaps incident to the serial form in which the author has chosen to expound his ethical system, is a somewhat tedious task. His work would gain both clearness and strength from a rigid condensation and the more thorough, concise and connected discussion of certain leading ideas—such as, *e. g.*, the conception of sociality as equivalent to morality, and the identification of ethics and sociology.

GEORGE S. PATTON.

PRINCETON UNIVERSITY.

NEW BOOKS.

Outlines of Metaphysics. JOHN S. MACKENZIE. London, The Macmillan Company. 1902. Pp. xvi + 172.

W. Wundt's Philosophie und Psychologie. RÜDOLF EISLER. Leipzig, J. A. Barth. 1902. Pp. vi + 212.

Le dottrine edonistiche italiane del secolo XVIII. MICHELE LOSACCO. Naples, Tip. della R. Università. 1902. Pp. 125.

The Elements of Mind. H. J. BROOKS. London, Longmans, Green & Co. 1902. Pp. xviii + 312.

Les obsessions et les impulsions. A. PITRES et E. RÉGIS. *Le caractère.* P. MALAPERT. (Bibl. intern. de psychol. expér.) Paris, O. Doin. 1902. Pp. 434.

Einheiten und Relationen. TH. LIPPS. Leipzig, J. A. Barth. 1902. Pp. 106.

Personal Idealism. HENRY STURT. London, The Macmillan Co. 1902. Pp. x + 394.

Crimes et anomalies mentales constitutionelles. A. FOREL et A. MAHAIM. Geneva, H. Kündig; Paris, Alcan. 1902. Pp. 302.

Das Problem der Willensfreiheit in der neuesten deutschen Philosophie. LEO MÜFFELMANN. Leipzig, Barth. 1902. Pp. 116.

Martineau's Religionsphilosophie. ORLO J. PRICE. (Diss., Leipzig.) No date. Pp. 104.

NOTES.

THE seventieth birthday of Professor Wundt was celebrated in August by the presentation of a *Festschrift*, containing contributions by a large number of his former students. The presentation was made at Tambach in Thuringia by a delegation consisting of Drs. Külpe, Kraepelin, Ludwig Lange, Kirschmann, Meumann, Mosch, Wirth and Frank Angell. The contributions form two large volumes of the *Studien*, the nineteenth and the twentieth, and are to be the final volumes under Professor Wundt's direction. It is understood that the new series will be conducted by Professors Külpe and Meumann. The former students of Professor Wundt, resident in America, who contribute researches to the *Festschrift*, are Professors Frank Angell, J. McKeen Cattell, Ewald Flügel, Chas. H. Judd, A.

Kirschmann, E. W. Scripture, Edward A. Pace, G. M. Stratton and E. B. Titchener. Professor Wundt was made an honorary citizen of the city of Leipzig.

THE recently established British Academy for the promotion of historical, philosophical and philological studies includes in its membership Dr. Edward Caird, Mr. S. H. Hodgson and Professor James Ward. Mr. A. Balfour and Sir Frederick Pollock are also members, though presumably not on account of their contributions to philosophy. The names of Professor Alexander Bain and Mr. Herbert Spencer are missing from the list. It is, however, known that Mr. Herbert Spencer declined to become a fellow of the Royal Society.

PROFESSORS JOSIAH ROYCE and George H. Palmer, of the philosophical department of Harvard University, have leave of absence for the present year. Professor Palmer has sailed for England.

THE Rev. Edward A. Pace, Ph.D., has been appointed director of the Institute of Pedagogy which the Catholic University of Washington has established in New York City. The Rev. Thomas E. Shields, Ph.D., of St. Paul, has been appointed instructor of physiological psychology in the Catholic University of Washington, filling the place vacant by Professor Pace's removal to New York.

DR. FELIX ADLER has been elected professor of social and political ethics in Columbia University.

DR. FRANCIS L. PATTON, formerly president of Princeton University, has been elected president of the Princeton Theological Seminary.

DR. GEORGE S. PATTON has been elected professor of moral philosophy at Princeton University.

DR. J. W. L. JONES, Ph.D. (Princeton), has been appointed professor of philosophy and education in Heidelberg University, Ohio.

DR. FRANK S. WRINCH, Ph.D. (Leipzig), of Toronto, has been appointed demonstrator in experimental psychology in Princeton University.

PROFESSOR WM. URBAN, Ph.D. (Princeton), of Ursinus College, Pa., has been appointed to the chair in Philosophy at Trinity College, Hartford.

BEGINNING November 1, 1902, all editorial matter for this REVIEW, together with books for notice, should be sent to Professor J. Mark Baldwin, Princeton, N. J. Business communications should be addressed as heretofore to Professor H. C. Warren, Princeton, N. J.

INDEX OF NAMES.

Names of contributors are printed in SMALL CAPITALS and the page numbers of the contributions in **Full Face Type**. In the case of authors reviewed the page numbers are in *Italics*, and in the case of mention in the notes they are in Roman type.

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